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Water Quality Inventory and Management Plan.

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WATER QUALITY INVENTORY AND MANAGEMENT PLAN

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WATER QUALITY BUREAU
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WATER QUALITY INVENTORY AND MANAGEMENT PLAN

MISSOURI-SUN-SMITH BASIN, MONTANA

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
DENVER, COLORADO

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WATER QUALITY INVENTORY AND MANAGEMENT PLAN

MISSOURI-SUN-SMITH BASIN, MONTANA

I. INTRODUCTION

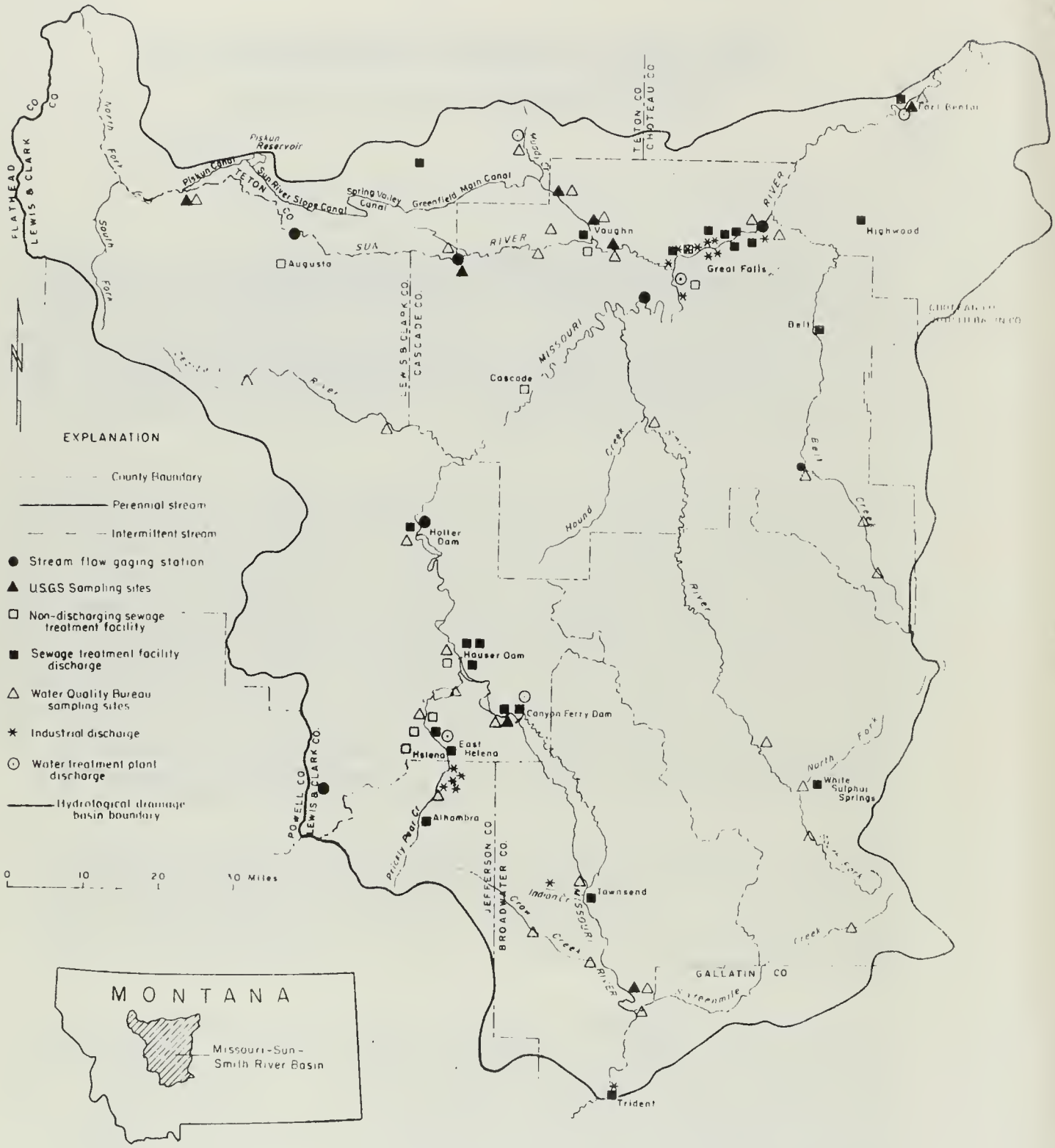
This report presents information relative to water quality and water quality inventory and management in the Missouri-Sun-Smith basin (Figure 1). This is one of sixteen basins designated by the state of Montana for preparation of water quality management plans. The Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500) have directed states to prepare such plans as part of a nation-wide program for controlling water pollution.

The objectives of this effort are to provide the state with water quality data and related information to (1) determine water quality characteristics of all natural and wastewaters, (2) determine factors, both natural and man-made which affect the quality of water, (3) develop a management strategy for maintaining and enhancing the quality of waters in the basin, and (4) provide information needed to determine whether Montana's water quality standards are being met and will continue to be met. Also included is a description of physical characteristics of the basin. The general methodology used in this study was the compilation and evaluation of existing water quality data and related information. Where information was deficient, field investigations and water and wastewater sampling and analyses were conducted to obtain needed information.

This investigation does not present a detailed analysis of the area's resources but summarizes water quality related information. As additional information becomes available, the Missouri-Sun-Smith basin water quality management plan will be revised and updated as part of Montana's Continuing Planning Process.

Assistance in obtaining information for this report was obtained from a number of agencies and persons. The Montana Department of Natural Resources provided information on land use, water use, economy and population. United States Geological Survey (USGS) personnel provided unpublished water quality data on stations maintained by the USGS. Federal waste discharge permit information was obtained from Richard T. Montgomery, U. S. Environmental Protection Agency State Engineer for Montana.

Figure 1 — Sketch map showing Missouri - Sun - Smith River Basin



II. SUMMARY AND CONCLUSIONS

There are 16 municipal, 10 agricultural, and 28 industrial discharges in the Missouri-Sun-Smith basin. Permits have been issued under the joint state-federal discharge permit system for 36 of these discharges. Permits for the remaining 18 are pending; seven of those pending are for agricultural discharges. Federal compliance schedules have been established for nine municipal and seven industrial discharges; best practicable treatment is required of industrial dischargers, and secondary treatment is required of municipal dischargers by July 1, 1977.

Even with the application of best practicable and secondary treatment to industrial and municipal discharges, respectively, all waters in the Missouri-Sun-Smith basin will not meet state water quality standards. Muddy Creek, the Sun River from Muddy Creek to the Missouri River and the Missouri River from the Sun River to the Marias River will remain water quality limited segments because of high sediment loads due principally to poor irrigation practices in the Muddy Creek drainage. An estimated 200,000 tons of soil are eroded annually (Bureau of Reclamation, May 23, 1974). Sand Coulee Creek, the Dry Fork of Belt Creek and Belt Creek downstream of the Dry Fork will remain water quality limited segments because of severe acid mine drainage. The Missouri River from Canyon Ferry Reservoir to Holter Dam was classified as water quality limited because of nuisance algal blooms. Agricultural activity in the Crow Creek drainage (near Toston, Montana) is the suspected cause. A study entitled NUTRIENT LOADS IN THE UPPER MISSOURI DRAINAGE, MONTANA has been undertaken to examine this problem.

Municipal facilities investments needed to achieve secondary levels of treatment for public sewage treatment facilities in the basin are estimated at approximately $31,559,900. Construction is underway to provide secondary treatment for Great Falls and Helena, the basin population centers. Several smaller communities in the basin need to upgrade sewage treatment facilities.

A surveillance plan for continued monitoring of water quality in the Missouri-Sun-Smith basin is described in this plan.

III. RELATED INVESTIGATIONS AND PLANS

TECHNICAL INVESTIGATIONS

There have been several limnological studies of Canyon Ferry Reservoir, Montana. Wright (1958) discussed the phytoplankton-zooplankton relationships in the eutrophic zone during September and October, 1956. Wright (1959) discussed chlorophyll content per unit volume of cells. Evidence was found of an interacting effect of temperature, light intensity, and phosphates on photosynthesis. Wright (1960) discussed standing crop density dependence on photosynthesis and its cause. Wright (1961) discussed the estimation of primary production from physical limnological data. Wright (1965) discussed birth, population and mortaility rates for a population of Daphnia Schodleri. Kaiser (1971) concluded temperature, competition, antibiosis and to a lesser extent predation, were the mechanisms controlling the rotifer populations in Canyon Ferry Reservoir. Bahls (1972) stated construction of the dam was the primary cause of cultural eutrophication at Canyon Ferry Reservoir. Flooding of nutrient-rich lands added to the Missouri River's fertility, but nutrients have not built up because of regular withdrawal of deep impounded water.

A 1971 through 1972 study of the extent and cause of eutrophication of Canyon Ferry Reservoir concluded the reservoir has become less eutrophic since 1957 (Wright, Rada and Martin, 1974). Phosphate loads to the reservoir were not increased by agricultural activities between Toston and Townsend. However, agricultural activities were the presumed cause of significantly increased nitrate concentrations in the Missouri River between Toston and Townsend. Nitrate quantity and concentration discharged from Canyon Ferry is greater than that which enters the reservoir. Nitrogen fixation by blue-green algae is the presumed cause. A considerable nutrient enrichment of the Missouri River occurs below Canyon Ferry because of the water regime of the reservoir (Wright, Rada and Martin, 1974).

A nutrient load study for the Missouri River from Three Forks to Holter Dam (Plate I) is being conducted by the Water Quality Bureau. Sampling is scheduled for completion on July 1, 1975, at which time waste load allocations will be developed for the Missouri River from Three Forks to Holter Dam.

In 1973, the Montana Fish and Game Department released a report on fish and wildlife resources in the Smith River drainage. Population densities and distributions, land management and water quality were studied. Turbidity, temperature, flow, pH and specific conductance were measured periodically at selected locations on major tributaries and the mainstem.

Acid mine drainage from abandoned coal mines in the Stockett-Sand Coulee, Montana, area was investigated by McArthur (1970). A study of field conditions and laboratory tests were performed to determine suitable methods to abate acid mine drainage pollution in the Sand Coulee Creek drainage. McArthur (1970) concluded flooding or neutralization by limestone were most practical.

A physical, chemical, bacteriological and biological survey of the Missouri River drainage in Montana was conducted during the summers of 1958 and 1959 by the Montana State Board of Health (now Montana Department of Health and Environmental Sciences). Data contained in this report is of limited usefulness due to changes in the drainage and limited sampling. Numerous field investigations and studies have been conducted by the Montana Department of Health and Environmental Sciences and the Montana Department of Fish and Game. Studies and field investigations, which pertain to this report, are discussed in Sections VI and VIII.

The Montana Water Resources Board (now the Montana Department of Natural Resources and Conservation, Water Resources Division) has published water resources surveys for all counties in the Missouri-Sun-Smith basin. These surveys are concerned primarily with existing and potential irrigation development and contain considerable data. Applicable sections of these surveys are discussed in Sections IV and VIII.

The Montana Department of Planning and Economic Development has published county-wide water and sewer plans for all counties in the Missouri-Sun-Smith basin. These plans delineate existing and future water and sewer collection and treatment facilities for all communities in the Missouri-Sun-Smith basin. Applicable portions of these surveys are discussed in Section VI.

An interim water quality management plan has been written for the Missouri River basin above Ervin Ridge (Montana State Department of Health and Environmental Sciences, January 25, 1972). In addition, interim project water quality management plans have been written concerning proposed sewage treatment works at Great Falls, Vaughn, Highwood and Helena (Montana State Department of Health and Environmental Sciences, December, 1972 and July 7, 1972).

AREAWIDE WASTE TREATMENT MANAGEMENT PLANS

There are no areawide waste treatment management plans in the Missouri-Sun-Smith basin under Section 208 of the Federal Water Pollution Control Act Amendments of 1972. None are anticipated in the next five years.

SECTION 201 FACILITY PLANS

No wastewater facility plans have been completed for any municipalities in the Missouri-Sun-Smith basin. Any sewage treatment facility construction grants awarded after July 1, 1974 will require, under the present federal grant program, a facility plan to be written by the municipality or its consulting engineers. Therefore, Townsend is preparing a Section 201 facility plan.

LEVEL B PLANS AND OTHER FEDERAL PLANS

A seven-volume study entitled THE MISSOURI RIVER BASIN COMPREHENSIVE FRAMEWORK STUDY (1971) is the only federal-state study which has been made for the Missouri River drainage. The Missouri-Sun-Smith basin is included in the Upper Missouri Sub-basin of the federal-state study. A Level B Plan, encompassing the Missouri-Sun-Smith basin, was started under the Western U. S. Water Plan but never completed because of budget cuts. Status of the plan is unknown. Type IV planning in Montana is administered by the U. S. Department of Agriculture. Type IV planning has not been initiated for the Missouri-Sun-Smith basin.

IV. BASIN PHYSICAL CHARACTERISTICS

The Missouri-Sun-Smith basin (Figure 1 and Plate I) includes the Missouri River drainage between the three forks of the Missouri and the mouth of the Marias River. Total drainage area is approximately 11,000 square miles or 7,000,000 acres. The Missouri River flows generally north and then northeast for about 250 miles from its formation by the confluence of the Jefferson, Madison and Gallatin Rivers to its confluence with the Marias River. All of Cascade County plus portions of Lewis & Clark, Broadwater, Jefferson, Gallatin, Meagher, Teton, Judith Basin, Chouteau and Park Counties make up the basin. Topography in the basin varies from very mountainous to rolling plains. Six sub-basins comprise the Missouri-Sun-Smith basin. These are Missouri River above Holter Dam, Smith River, Missouri River from Holter Dam to the Sun River, Dearborn River, Sun River, and Missouri River from Sun River to Marias River.

There are 12 municipal waste dischargers, 19 industrial waste dischargers, 38 water quality monitoring stations, 45 streamflow gaging stations, and 28 weather stations in the basin (Plate I). All surface waters within the Missouri-Sun-Smith basin have been classified by the state of Montana according to use and existing water quality. Most waters in the basin have been classified as B-D_1 by the state of Montana. Water of this classification is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

McClellan Creek drainage to the East Helena water supply intake, Ten Mile Creek drainage to the Helena water supply intake and O'Brien Creek drainage to the Neihart water supply intake are classified A-Open-D_1. Willow Creek drainage (tributary of the Smith River) to the White Sulphur Springs water supply intake is classified A-Closed. A-Open-D_1 waters are to be maintained suitable for drinking, culinary and food processing purposes after simple disinfection and removal of naturally present impurities; all other criteria are the same as for B-D_1. A-Closed waters are to be maintained suitable for drinking, culinary and food processing purposes after simple disinfection. Public access and activities such as livestock grazing and timber harvest are controlled by the utility owner under conditions prescribed and orders issued by the department.

The Missouri River from Sun River to Rainbow dam, a distance of about six miles, is classified B-D_2 by the state of Montana. Between Rainbow Dam and the mouth of the Marias River, the Missouri River is classified B-D_3 by the state of Montana. To meet a B-D_2 classification, stream quality is to be maintained suitable for marginal propagation of salmonid fishes and associated aquatic life. All other criteria are the same as for B-D_1. To meet a B-D_3 classification, stream quality is to be maintained suitable for growth and propagation of non-salmonid fishes and associated aquatic life. Belt Creek (mainstem) from Otter Creek (near Belt, Montana) to the Missouri River is classified B-D_2. The Sun River (mainstem) from Muddy Creek to the Missouri River is classified B-D_3.

Prickly Pear Creek (mainstem) from the Montana Highway No. 433 crossing about one mile northwest of East Helena to Lake Helena is classified E-F. The Muddy Creek drainage (near Vaughn, Montana) is also classified E-F. The quality of E-F waters is to be maintained for agricultural and industrial water uses other than processing. All other surface waters in the basin are classified B-D_1.

Detailed water quality criteria for all waters in the basin are shown in Appendix B.

Most streams within the Missouri-Sun-Smith basin have been classified as effluent limited by the state of Montana. Exceptions are segments of the Missouri River, Muddy Creek, lower portions of the Sun River and Belt Creek, the Dry Fork of Belt Creek, and Sand Coulee Creek, which have been designated as water quality limited.

Streams or stream segments designated as water quality limited do not meet Montana water quality standards and are not expected to meet Montana water quality standards, even after application of effluent limitations required by sections 301(6)(1)(A) and 301(b)(1)(B) of the Federal Water Pollution Control Act. Streams or stream segments designated as effluent limited meet and will continue to meet Montana water quality standards or are expected to meet Montana water quality standards after application of effluent limitations required by sections 301(b)(1)(A) and 301(b)(1)(B) of the Federal Water Pollution Control Act.

CLIMATE

Greatly varying topography plays a large part in the basin's climate pattern. The semi-arid climate of the valleys and rolling plains is typified by cold, dry winters; cool, moist springs; and warm summers. Annual precipitation in these areas usually ranges between 10 and 15 inches. Mountain areas, particularly along the Continental Divide, receive significant snowfall during winter months. Snow depths exceeding 250 inches have been recorded. This accumulation of winter snows in the mountains provides large stream flows in April through June.

Operating weather stations in the basin are listed in Table 1. Stations at Helena and Great Falls are maintained by the National Oceanographic and Atmospheric Administration (NOAA). All other stations listed are maintained by private individuals, private industry, or other govermental agencies under cooperative agreement with the NOAA. Basin weather

can be characterized by data collected at Great Falls and Helena. Normal monthly temperatures and precipitation for Great Falls and Helena from 1931 to 1960 are shown in Figure 2.

TABLE 1. WEATHER STATIONS IN THE MISSOURI-SUN-SMITH BASIN

Station Name	Years of Record Temperature	Precipitation	Gage Type
Augusta	60	63	Recording
Austin 1W	22	22	Non-recording
Bench Mark	-	23	Non-recording
Canyon Creek	-	28	Non-recording
Canyon Ferry PH	16	16	Non-recording
Cascade 20SSE	15	16	Non-recording
Cascade 5S	58	68	Non-recording
Deep Creek Pass	-	10	Non-recording
Fairfield	46	46	Non-recording
Fort Benton 20NW	-	13	Recording
Fort Benton	56	68	Non-recording
Fort Logan 3ESE	0	20	Non-recording
Gibson Dam	51	55	Recording
Great Falls WSO AP	80	81	Recording
Helena 6N	-	49	Non-recording
Helena WSO AP	93	93	Recording
Highwood 7NE	-	63	Non-recording
Highwood	-	28	Recording
Holter Dam	62	69	Recording
Marysville No. 3	-	77	Non-recording
Millegan	-	34	Recording
Kings Hill	-	5	Non-recording
Neihart 8NNW	6	6	Recording
Power 6SE	-	19	Non-recording
Raynesford 2NNW	3	3	Non-recording
Rogers Pass 6NE	9	9	Non-recording
Rogers Pass	0	20	Non-recording
Shonkin 7S	19	19	Non-recording
Simms	-	23	Recording
Sun River 5SW	17	31	Non-recording
Toston 3SW	15	15	Non-recording
Townsend 12ENE	-	34	Recording
Townsend	35	36	Non-recording
Trident	35	35	Non-recording
Ulm 4SE Truly	-	25	Non-recording
White Sulphur Springs 24NW	8	8	Non-recording
White Sulphur Springs 10N	-	23	Non-recording
White Sulphur Springs	54	58	Recording

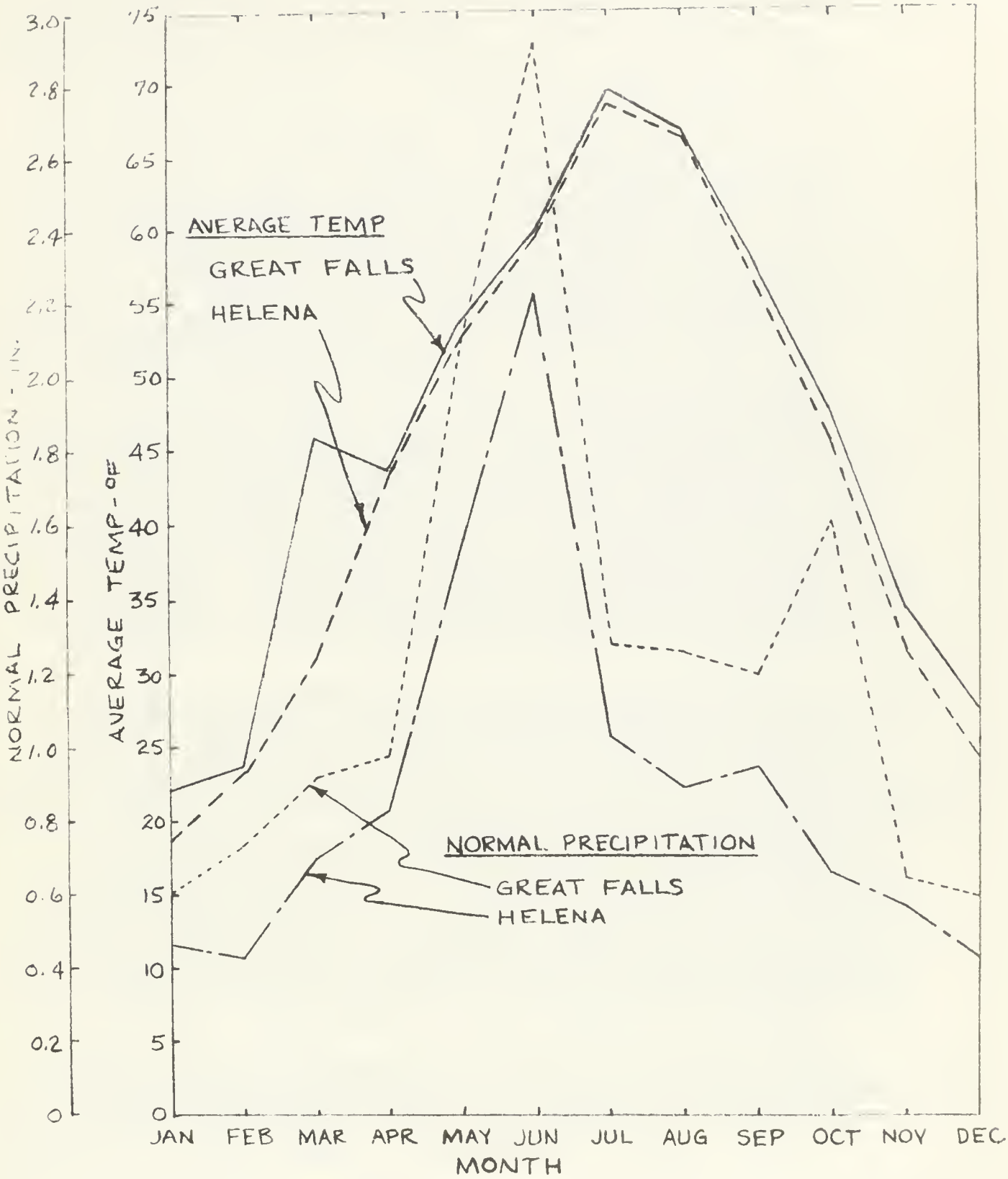


FIGURE 2. AVERAGE TEMPERATURES AND NORMAL PRECIPITATION FOR MISSOURI-SUN-SMITH BASIN (Based on NOAA data for Great Falls and Helena from 1931 to 1960)

HYDROGEOLOGY

Groundwater resources in the Missouri-Sun-Smith basins are used for stock, domestic, municipal and irrigation purposes. Surface water is more widely used in the basin, but groundwater is used by a large number of people and is a valuable water source for the basin.

A wide variety of geologic formations are present in the Missouri-Sun-Smith basin, ranging in age from Pre-Cambrian (greater than 600 million years old) to Recent (less than 20,000 years old). Rock types in the area include a wide variety of sedimentary, volcanic and instrusive rocks, and a variety of unconsolidated to semi-consolidated alluvial deposits. In the geological past, the area has undergone significant deformation of the earth crust and long periods of erosion and sedimentation. Mountain ranges of the basin were created by widespread uplift of bedrock formation that subsequently have undergone varying amounts of erosion. Between the mountain ranges are large valleys filled with thick deposits of consolidated to semi-consolidated sedimentary materials. The northern part of the basin (north of Great Falls) is the south edge of a broad plains area underlain by a thick sequence of sedimentary formations. In the geological past, this plains area has undergone repeated glaciation by continental glaciers. The occurrence, availability and quality of groundwater in the basin is directly related to geological conditions. There are a number of technical reports that describe the geology and groundwater resources of the area.

Bedrock formations exposed in the mountainous portions of the basin include limestone, shale, dolomite, argillite, quartzite, and a variety of volcanic and granitic rocks. The water-bearing capabilities of these formations varies widely, but generally, bedrock formations are poor aquifers and do not yield large quantities of water to wells. Some bedrock formations, such as the Madison Formation of Mississippian Geological Age, can yield large quantities of good quality water to wells. Other bedrock formations, such as the Colorado Formation of Createous Geological Age, are thick, widespread shales but yield quantities of poor quality water. Bedrock formations usually are exposed in and around the mountains or are at relatively shallow depths beneath glacial or alluvial deposits.

Another important source of groundwater in the Missouri-Sun-Smith area is large intermountain valleys containing unconsolidated to semi-consolidated sediments of Tertiary Age (one to 65 million years old). The total thickness of Tertiary deposits range from a few feet to over 1,000 feet.

Tertiary deposits are generally fair to poor aquifers that yield small amounts of fair to poor quality water to wells. Locally permeable layers, lenses or channel deposits will yield moderate to large quanitites of water, but location of such zones are poorly known. Groundwater from the Tertiary is generally suitable for most uses, and if present in sufficient quantities, it can be used for irrigation. The large valleys in the vicinity of Helena, White Sulphur Springs and Townsend are Tertiary sediment-filled valleys.

The northern part of the Missouri-Sun-Smith basin in the vicinity of Great Falls and northward has, in the past, been covered by glacial deposits of Pleistocene Age, consisting of compacted mixtures of boulders, sand, gravel, silt and clay. These deposits range in thickness from a few feet to over 100 feet and generally yield small quantities of poor quality water to wells. In some areas, however, glacial channels and outwash deposits can yield large quantities of fair to good quality water.

In addition to bedrock, Tertiary sediments and glacial deposits, there are widespread deposits of unconsolidated to semi-consolidated alluvium of Recent Age (less than 20,000 years old). Such deposits are present along major stream drainages in the area and consist of unconsolidated sand, silt and clay. These relatively thin alluvial deposits generally yield moderate quantities of good quality water to wells. In some areas, however, the recent alluvial deposits are thin and will yield little, if any, water; and in other areas, alluvium yields water of a poor quality.

Pollution of groundwater has occurred in a number of areas in the Missouri-Sun-Smith basin. Probably the most severe area of pollution is on the Highwood Bench where saline seep problems have appeared in the last few years. This is caused by infiltration and precipitation and solution of soluble salts followed by evaporation at points of groundwater discharge. The problem is under intensive investigation by numerous organizations. Acid mine drainage is present from metal mines in Carpenter, Galena, Lump Gulch and Spring Creeks, and acid waters are draining from coal mines near Belt and in the Sand Coulee drainage. Sewage stabilization lagoons generally have seepage into the groundwater and create localized areas of groundwater pollution. However, there have been no problems due to lagoon seepage reported. There are 20 sewage lagoons in the basin.

Septic tank and subsurface disposal can create localized areas of groundwater pollution. Where there are large numbers of septic tanks and individual water supplies using wells,

groundwater pollution can lead to public health problems if improperly designed and located. Such problems have been tentatively identified in several areas in the basin but have not been thoroughly investigated.

The only known groundwater pollution from industry in the basin is some toxic metal-bearing wastes that have entered the ground in the vicinity of the Anaconda Company facility in Great Falls. This pollution is not known to be a significant problem.

SOILS

Soils of the Missouri-Sun-Smith basin are as varied as the physiographic features. This area is transitional between the main range of the Rocky Mountains and the vast continental slope known as the Northern Great Plains. The mountains enclose intermountain basins, which are sometimes characterized by different erosional levels. Soils were derived from parent materials originally located in valleys or adjacent mountains. These parent materials were eroded, transported and deposited by various processes, including glaciation. Resulting soils consist of glacial material, alluvium and lake deposits or the alteration products of these materials.

Soils of steep land generally are well-drained stony loams or are granitic with rock outcrops. Depth to rock can vary from 6 to 60 inches. Severe erosion hazards under improper management can occur. Loams and clay loams with variable amounts of gravel and cobbles occupy high benches and residual uplands. They mantle bedrock at various depths. These soils usually are well drained and present slight to moderate erosion hazards.

Soils on fans and intermediate terraces range from deep, well-drained sandy loams and excessively drained, very gravelly and cobbly loamy soils to well-drained loams and silt loams high in lime. Shallow wet soils can occur along the drainageways. Associated with these are moderately well-drained, strongly alkaline loams and clay loams that are slowly permeable and have hard, crusty surfaces. Most soils on the fans and intermediate terraces present slight to moderate erosion hazards. Alluvial soils of the flood plains, low terraces and narrow valleys are quite variable. Some are loamy soils subject to flooding. Some are poorly drained soils with moderate to strong salinity, while others are moderately well to well-drained soils that can be more than 40 inches deep to sand and gravel. Under proper management, these soils present slight erosion hazards.

In the northern portion of the study basin and to the east of the front range of the Rocky Mountains lies the foothills region and Northern Great Plains. The foothills are dominated by moderately deep, well-drained stony loams. Moderately well-drained loams and gravelly loams have developed on the terraces and outwash benches with some dense, very slowly permeable subsoils on low terraces and along drainageways. Included are areas of saline soils. Deep, well-drained calcareous clay soils have developed on nearby level to undulating glacial meltwater deposits.

Soils in the Missouri-Sun-Smith River basin support timber production, native range, dryland agriculture and irrigated crop production. Valley soils generally have been amenable to the use of septic tank drainfields. However, soil permeability in the Missouri-Sun-Smith basin varies greatly and may not be compatible with subsurface disposal in many areas. Areas of extensive clay deposits require special care in the construction of drainfields for septic tanks.

LAND USE

Great Falls (population 60,091) and Helena (population 22,730) are the major population and trade centers in the basin. Agriculture is the leading industry in the planning area with livestock production the major operation. Irrigated lands produce feed for livestock and cereals for human consumption. Drylands produce grain crops, primarily wheat, with some livestock forage crops. Total area within the planning area is distributed among the major uses as shown in Table 2. Two-thirds of the area is in private ownership or other non-federal control and is used primarily for range or crops. Control of the remaining third is distributed among the Forest Service, Bureau of Land Management and other federal agencies and is used principally for grazing and forest use.

(1) TABLE 2. LAND USE IN THE MISSOURI-SUN-SMITH BASIN (Thousands of Acres)

Control	Acreage	Irrigated	Dryland	Total	Pasture	Range	Forest	Wilderness	Other
Non-federal	4,900	280	900	1,180	80	2,280	610	-	150
USFS	1,730	-	-	-	-	290	1,130	310	-
BLM	230	-	-	-	-	200	20	-	10
Other federal	180	-	-	-	-	0	-	-	180
TOTAL	7,040	280	900	1,180	80	3,370	1,760	310	340

(1) Numbers given have been estimated from Montana Department of Natural Resources and Conservation data for the Missouri River drainage from Toston to Fort Benton, Montana.

WATER USE

Irrigation is the predominant consumptive use of water in the Missouri-Sun-Smith drainage, consuming an estimated 295,000 acre-feet annually. Much of this irrigation has been developed privately by individuals and small groups through construction of diversions, small dams and reservoirs and extensive water-spreading systems. However, several projects have been developed by federal and state agencies. These are summarized in Table 3.

TABLE 3. PRESENT IRRIGATION DEVELOPMENT

Name	Stream	Agency	Description
Crow Creek Pump Unit	Missouri River	B.R.[1]	Pumping plant, canals, laterals and drains to serve 5,031 acres of land.
Broadwater	Missouri	Montana	Concrete diversion dam across the Missouri River near Toston, 48.2 miles of canal to irrigate 21,000 acres.
Chessman	Beaver Creek	City of Helena	Not irrigation, storage for public supply.
Canyon Ferry	Missouri River	B.R.	Outlet in dam serves pumps of Helena Valley Unit.
Helena Valley Unit	Missouri River	Montana	Main canal, regulating reservoir and canals, laterals and drains, constructed to serve 14,147 acres.
N. Fork Smith River Reservoir (Lake Sutherlin)	North Fork Smith River	Montana	Demand storage 11,600 acre-feet.

(1) Bureau of Reclamation

Name	Stream	Agency	Description
So. Side Canal	Smith River	Montana	Canal 12.5 miles long for 2,000 acres.
Florence Canal	Smith and Ford Creeks	Montana	16.3 miles of canals using 2,490 acre-feet of reservoir storage a year.
Nilan Reservoir	Smith and Ford Creeks	Montana	Two dams to create off-stream reservoir with capacity of 10,000 acre-feet and 10.7 miles of canal.
Sun River Project	Sun River	B.R.	Gibson Dam and reservoir diversion dams, off-stream storage reservoirs (Piskun and Willow Creek) and system of canals, laterals and drains to serve 90,947 acres. Total storage of 184,000 acre-feet.

There are 17 reservoirs and run-of-river impoundments within the basin having a total storage of 1,000 acre-feet or more per development. The three largest reservoirs are Canyon Ferry, located on the Missouri and having a total capacity of 2,050,900 acre-feet; Holter, also on the Missouri, total capacity of 240,420 acre-feet; and Gibson, located on the Sun River, total capacity of 104,780 acre-feet. Six of the dams were constructed for water power development only. The seventh, Canyon Ferry, is a multi-purpose project. Total evaporation from reservoirs is estimated to be 79,000 acre-feet per year.

Groundwater development is still very much in its infancy in the study area with most usage taking place in and near cities and towns. Domestic and stock water are the dominant claimed uses with minor irrigation (garden and lawn) close behind. In most counties studied, the area wells predominantly were used for domestic purposes and springs predominantly for stock purposes. The potential exists for further groundwater development in the area without jeopardizing the groundwater supply. As of October 1, 1972, 5,321 field groundwater appropriations (wells and springs) were on record in the basin.

The Montana Department of Natural Resources and Conservation estimates 9,000 acre-feet of water is consumed annually by municipal and industrial uses. Estimated annual water consumption for communities in the basin is summarized in Tables 4 and 5.

TABLE 4. COMMUNITIES WITH SURFACE WATER SUPPLIES[5]

Community	Estimated Consumption million gallons/year	Source
Great Falls[3] Black Eagle[4]	5,110	Missouri River
Helena[1,2]	2,630	Tenmile Creek Missouri River Oro Fino Gulch
East Helena[1,6]	210	McClellan Creek
Cascade[1,7]	20	Springs
Fort Benton[7]	51	Missouri River
White Sulphur Springs[7]	33	Willow Creek
Neihart[7]	3	O'Brien Creek
Canyon Ferry[7]	12	Missouri River

(1) These communities also use municipal wells. Estimated yearly consumption includes well supply.
(2) Helena, December 17, 1973.
(3) Great Falls, July 12, 1974.
(4) Connected to Great Falls, Montana, water supply.
(5) Communities with populations under 100 are not considered.
(6) East Helena, June 28, 1974.
(7) A per capita consumption of 75 gallons per day is assumed (USPHS, 1967; Steel, 1960; Fair, Geyer and Okun, 1966).

TABLE 5. COMMUNITIES OF OVER 100 POPULATION WITH GROUNDWATER SUPPLIES

Community	No. Well Used	Ownership	Well Data Capacity (GPM)	Well Data Depth (ft.)	Estimated Consumption[1] million gallons/year
Helena	1	Municipal	350	-	2,632[2]
East Helena	2	Municipal	1,000		45.2[2]
Toston	-	Private	-	60	2.8
Augusta	-	Private	0	20-30	13.7
Maudlow	-	Private	-	60-100	2.7
Wolf Creek	-	Private	-	65	2.7
Clancy	-	Private	-	-	6.3
Jefferson City	-	Private	-	-	2.7
Marysville	-	Private	-	65	2.7
Fort Shaw	-	Private	15-30	10-30	4.1
Sun River	-	Private	15-30	10-30	5.9
Simms	-	Private	10-120	30	8.0
Vaughn	2	Municipal	1,500	100	5.5
Belt	1	Municipal	1,000	30	17.8[2]
Stockett	1	Municipal	40	10	13.7[2]
Sand Coulee	1	Municipal	85	210	8.2
Ulm	-	Private	5-20	10-200	8.5
Townsend	3	Municipal	2,200	-	37.5
Highwood	3	Municipal	235	-	4.1
Carter	1	Municipal	-	-	2.7
Fairfield	3	Municipal	500	-	17.8

(1) A per capita consumption of 75 gallons per day is assumed (USPHS, 1967; Steele, 1960; Fair, Eyer and Okun, 1966).

(2) These communities also use surface water for domestic supply. Estimated annual consumption includes both sources.

No large-scale water development projects are proposed for the basin at this time. The Soil Conservation Service (SCS) is developing diversion and reservoir capabilities for the Sheep Creek diversion/Newland Creek irrigation project near White Sulphur Springs.

POPULATION AND ECONOMY

Great Falls and Helena are the dominant population and economic centers in the basin. Great Falls is a center for agriculture, wholesale and retail trade, industry and transportation. Substantial Air Force and Air National Guard contingents are located at Great Falls. Helena is the state capital with substantial employment in state and federal government. It is also a retail trade center and site of the state headquarters of Mountain Bell Telephone Company.

Communities in the Missouri-Sun-Smith basin with 100 or more people are listed in Table 6 with their 1970 populations.

TABLE 6. COMMUNITIES OF 100 OR MORE PEOPLE

Community	County	1970 Population
Toston	Broadwater	100
Townsend	Broadwater	1,371
Belt	Cascade	656
Black Eagle	Cascade	2,200
Cascade	Cascade	714
Fort Shaw	Cascade	150
Great Falls	Cascade	60,091
Neihart	Cascade	109
Sand Coulee	Cascade	300
Simms	Cascade	300
Stockett	Cascade	500
Sun River	Cascade	215
Ulm	Cascade	310
Vaughn	Cascade	200
Carter	Chouteau	100

Community	County	1970 Population
Fort Benton	Chouteau	1,863
Highwood	Chouteau	154
Maudlow	Gallatin	100
Clancy	Jefferson	230
Jefferson City	Jefferson	100
Augusta	Lewis & Clark	500
Canyon Ferry	Lewis & Clark	435
East Helena	Lewis & Clark	1,651
Helena	Lewis & Clark	22,730
Marysville	Lewis & Clark	102
Wolf Creek	Lewis & Clark	100
White Sulphur Springs	Meagher	1,200

As shown in Table 7, population and total employment in the basin have a long-term history of increasing. This trend is projected to continue. The major identifiable trend in employment mix is a decline in agriculture and an increase in services and other employment. This trend is expected to continue. Therefore, the rural population is expected to continue declining. According to the 1970 census, the basin population consisted of 93,633 urban residents (78 percent) and 27,032 rural resident (22 percent).

TABLE 7. MISSOURI-SUN-SMITH RIVER BASIN POPULATION AND EMPLOYMENT HISTORICAL AND PROJECTED, 1930 - 1985

	1930	1940	1950	1960	1970	1980	1985
Population	64,882	70,363	83,212	107,677	120,667	141,307	150,671
Employment Total	28,117	25,692	32,568	38,207	42,914	48,364	50,996
Agriculture	5,377	4,168	3,817	2,893	2,434	(1)	(1)
Forest and Fisheries	57	61	54	81	126	(1)	(1)
Mining	1,073	1,315	343	244	155	(1)	(1)
Construction	1,667	1,403	2,659	3,176	3,162	(1)	(1)
Manufacturing	4,924	3,327	4,014	4,502	4,322	(1)	(1)
Services and Other	15,019	15,418	21,681	27,311	32,715	(1)	(1)

(1) Not available

BIOLOGICAL CONDITIONS

Aquatic habitats in this basin range from cold mountain streams and lakes to warm lowland streams and lakes. There are several large ephemeral habitats in large shallow irrigation reservoirs. All types of substrates and silt loads are present in the basin. Only Little Prickly Pear Creek and the Smith River sub-basin have been studied in detail; the Smith River study dealt only with fish. A two-year biological study of the Sun River is in progress (Johnson, 1974). Cold-water habitats in the Missouri-Sun-Smith basin contain Cutthroat, Rainbow, Brown and Brook trout; Kokanee (in the Missouri River impoundments) and Coho Salmon (in Bean Lake); and Mountain Whitefish; plus numerous non-game species. Warm-water habitats contain Sauger, Northern Pike, Walleye, Channel Catfish, Goldeye, Pallid and Shovelnose Sturgeon, as well as many other species of fish (Brown, 1971).

The Missouri River and its impoundments above Morony Dam and most smaller streams in this basin are cold-water habitats. The smaller streams are usually in good condition except for agricultural dewatering and loss of habitat due to bank damage and channel alterations. Because of its size and mainstream impoundments, the Missouri River has very stable habitats. Canyon Ferry has suffered from drawdown, which exposes large mud flats near the upper end. This problem may be solved (or changed) by dike construction, which is underway.

The Sun River is a good cold-water habitat in its upper reaches. After it leaves the mountains, it is degraded by irrigation withdrawals. It is further degraded by the silt input from Muddy Creek. It becomes a warm-water habitat below its junction with Muddy Creek. The Dearborn River also suffers from dewatering (below Bean Lake) and silt input (principally from Flat Creek). Little Prickly Pear Creek is also dewatered below Wolf Creek Canyon and has been damaged by channel alterations in the canyon (Johnson, 1974).

Prickly Pear Creek is damaged by acid mine drainages in its headwaters and by occasional toxic industrial spills near East Helena. It is dewatered below East Helena during the irrigation season and in its lower reaches, the stream is used for disposal of Helena's poorly treated primary sewage (Johnson, 1974).

The lower reaches of Crow Creek are dewatered, but the upper reaches are in good condition (Konizeski, 1970). Sixteen Mile Creek may be degraded by the silt load of Battle Creek

(Helena National Forest, 1973). The Smith River also suffers from low flows as appropriated water exceeds the water present (Wipperman, 1973). Belt Creek suffers from acid mine discharges in its headwaters and is dewatered naturally in its lower reaches (Johnson, 1974).

V. MONTANA WATER POLLUTION CONTROL PROGRAM

Water quality management planning is part of a broad comprehensive water pollution control program administered by the Water Quality Bureau of the Environmental Sciences Division. This program is described in the program plan of the Water Quality Bureau (1974). Important elements of the state program are:

1. State and federal waste discharge permit program.
2. Water quality standards.
3. Facilities construction grants, plan review, operation and maintenance inspections, training, and licensing of operators.
4. Statewide monitoring and surveillance program.
5. Public participation.
6. Enforcement.

STATE AND FEDERAL WASTE DISCHARGE PERMIT PROGRAM

The 1955 Montana state law established a waste discharge permit program. A revision of this law in 1967 required a permit for all discharges. Regulations and a formal state permit program were established in 1968 for the discharge of sanitary sewage and municipal wastes to waters of the state. In 1972, a waste discharge permit regulation for confined livestock feeding was adopted by the Board of Health and Environmental Sciences. All operations feeding livestock for marketing purposes within any confined area or enclosure not normally used for raising crops or for pasture, which at any time discharges drainage water to a state water, is required to have a permit. Existing operations were required to have a permit before June 24, 1974. All new or expanding operations are required to have a permit.

The Federal Water Pollution Control Act Amendments of 1972 established a national permit system. Industrial, municipal, and other point source discharges will be required to obtain permits to discharge pollutants into navigable waters or their tributaries. The EPA (U. S. Environmental Protection

Agency) has given authority to allow states to administer the permit program providing the states conform to certain guidelines. On June 11, 1974, Montana assumed most of the federal permit program.

Waste discharge permits are an effective tool for regulating discharge of potentially harmful effluents into Montana lakes and streams. Treatment works will be required to meet specific effluent standards. In most instances, the discharger will be responsible for certain monitoring information; for example, sampling and analysis of the water at specified intervals. In instances where effluent being discharged does not meet state standards, the permit is issued on a "compliance" basis with stipulations as to what corrections will be made and when.

The act also provides that the permit program will achieve, not later than July 1, 1977, effluent limitations for point sources, other than publicly owned treatment works, which shall require the application of best practicable control technology. For publicly owned treatment works, secondary treatment of wastes will be required by July 1, 1977. The act further specifies that by July 1, 1983, effluent limitations for point sources, other than publicly owned treatment works, shall require application of the best available technology. Publicly owned treatment works shall achieve best practicable treatment by July 1, 1983.

These steps will result in progress toward a national goal of eliminating the discharge of all pollutants by 1985.

WATER QUALITY STANDARDS

Water pollution control was started officially in Montana in 1907 with the passage of legislation designed to protect domestic water supplies. A law passed in 1955 was more comprehensive. It dealt with the control and protection of water for additional uses--recreation, agriculture and industry. The law also established a Water Pollution Control Council and charged it with the tasks of classifying all streams in the state according to their most beneficial uses and establishing water quality criteria for the streams. It also involved upgrading the treatment of wastes going into the streams. Montana, thus, became one of the first states to have enforceable stream classifications.

In 1965, the U. S. Congress passed the Federal Water Quality Act, which required that all states classify and establish water quality criteria for their interstate streams by

July 1, 1967. This resulted in Montana revising its standards for both interstate and intrastate waters and required a higher degree of stream quality than before. Secondary treatment or the equivalent was required of municipal and industrial discharges. Primary treatment or the equivalent was required before passage of the act.

In October, 1972, the Federal Water Pollution Control Act Amendments were passed by Congress expanding the authority of the Environmental Protection Agency. Uniform water quality standards and enforcement procedures throughout the United States is the objective. For example, industrial waste dischargers throughout the nation manufacturing the same product will have uniform discharge requirements, based on the amount of product produced. Again, Montana was required to revise its water quality standards. The Department of Health and Environmental Sciences adopted revised standards on July 13, 1973. The new standards became effective in November, 1973.

Montana water quality standards serve as a functional tool in protecting water quality; however, there are a number of laws, statutes and regulations which complement the water quality standards and significantly assist in protecting water quality.

STATEWIDE MONITORING AND SURVEILLANCE PROGRAM

Prior to 1972, Montana had done little monitoring due to lack of funds. With increased appropriations provided by the 1971 legislature and the federal government, the state greatly increased its efforts. Staff were added and laboratory equipment purchased. The present state monitoring program includes periodic compliance monitoring of municipal and industrial wastes, long-term base line monitoring of streams, and a statewide program for determining the general quality of all significant surface waters.

The statewide inventory of water quality will indentify areas with water quality problems and will provide basic data for water quality management and planning programs. Included in the monitoring is a statewide assessment of the trophic (pollution level) status of Montana's lakes, reservoirs and ponds. This program is coordinated with the EPA National Eutrophication Survey.

FACILITIES CONSTRUCTION, OPERATION AND MAINTENANCE

A minimum requirement of primary treatment for all domestic sewage was first adopted by the Montana Board of Health in

1952. All of Montana's communities have met this requirement, and many of the communities are upgrading their facilities to secondary treatment or are in the process of constructing or planning secondary systems. Since 1956, there has been a federal grant program to assist municipalities in the construction of sewage treatment facilities, including outfall and interceptor sewers. In 1971, the Montana state legislature appropriated $4,000,000 to aid municipalities in construction of these same facilities. The 1973 legislature appropriated $1,600,000 to reimburse municipalities that had proceeded with construction since July 1, 1966 without waiting for state grants. With passage of the Federal Water Pollution Control Act Amendments of 1972, 75 percent of eligible project costs are federally financed. Due to a shortage of federal grant funds, a priority system for fund allocation must be used. The state, under EPA guidance, establishes priorities for proposed waste treatment projects.

An important part of municipal sewage treatment is proper operation and maintenance of facilities after construction is completed. In an effort to improve operation and maintenance, the state has conducted an operators' school each year. During recent years, this school has had about 100 operators attending. In 1971, a grant was obtained from the federal government for employing two training instructors to establish training programs throughout the state in addition to the annual school.

An operators certification program was established in 1968 following enactment of a law requiring certification of those in responsible charge of a sewage treatment or industrial waste treatment system.

PUBLIC PARTICIPATION

Public participation in water pollution control is an increasingly important aspect of the state program. Public hearings are held concerning proposed regulations, water quality management plans, and waste discharge permit applications. The state also has an environmental impact statement requirement. These statements are presented to the public for comment, and hearings are conducted on highly controversial issues.

The public is also kept informed by means of a Water Pollution Control Advisory Council, which has been established by law to assist the Water Quality Bureau in preparation of rules and regulations and in dissemination of information to interested groups. Similarly, public meetings are attended on request, and a bi-monthly newsletter is published by the Water Quality Bureau.

ENFORCEMENT

The 1955 Montana state law provided enforcement procedures. These laws were revised in 1971 to provide better enforcement, and an attorney was added to the staff of the Department of Health and Environmental Sciences to aid in enforcement. The state permit system provides a primary means for enforcement. Violators of permit conditions or discharges without a permit can lead to enforcement.

VI. WATER POLLUTION SOURCES

Water pollution in the Missouri-Sun-Smith basin is caused by several factors, including municipal and industrial discharges, acid mine drainage from inactive mines, run-off from mismanaged and erodible soils and agricultural wastewaters. Characteristics of significant municipal and industrial discharges are summarized in Tables 8 and 9, respectively.

MUNICIPAL DISCHARGES

Several communities in the study basin discharge treated sanitary wastewater and water treatment plant backwash water to adjacent streams (Figure 1 and Plate I). Helena and Great Falls provide primary wastewater treatment. Most other communities use or plan to use lagoons. Great Falls, Helena, Power and Fort Benton have water treatment plant discharges.

Great Falls Sewage Treatment Plant

Existing primary treatment facilities were completed in 1961. Treatment processes include grit removal, screening and grinding, primary sedimentation, heated digestion and mechanical dewatering of solids removed by sedimentation, and chlorination of settling basin liquid effluent before discharge to the Missouri River (Design Report, 1970 and Basis of Design Memorandum, 1972). Average flow in 1969 was 11.4 mgd.

Improvements to the existing plant plus construction of secondary treatment facilities are underway. Estimated average flow for the design year, 1990, is 21 mgd. Proposed facilities will provide secondary treatment using the conventional activated sludge process.

Great Falls Water Treatment Plant

Missouri River water is treated at this facility to provide supply for the city of Great Falls. Treatment consists of coagulations, flocculation, sedimentation, filtration and disinfection. Filter backwash, sedimentation, basin underflow and untreated sanitary wastes are discharged to the Missouri River via a single outlet. Filter sludge is discharged to the river without treatment.

TABLE 8. CHARACTERISTICS OF SIGNIFICANT MUNICIPAL DISCHARGES

WASTE SOURCE[1] AND LOCATION	WASTE SOURCE IDENTIFICATION DATA: TREATMENT TYPE	RECEIVING WATER	DISCHARGE PERMIT NO.	DISCHARGE TYPE	DATE SAMPLED	DISCHARGE CHARACTERISTICS (Units are mg/l unless otherwise shown).	
Great Falls STP[2] (20N3E1BDB)	Primary with chlorination	Missouri River	MT 0021920	Continuous	12/5/73	Flow . . . 19.4 cfs BOD_5 . . . >48 TSS . . . 136 Residual chlorine 0.0	pH . . . . . 7.2 S.U. Fecal coliforms . . 10,000/100 ml
Great Falls WTP[3] (20N3E14ABD)	None	Missouri River	MT 0000442	Intermittent	12/6/73	Flow . . . 10.2 cfs TSS . . . 532	pH . . . . . 7.6 S.U. Residual chlorine . 0.50
Helena STP (10N3W16DB)	Primary with chlorination	Prickly Pear Cr.	MT 0022641	Continuous	11/24/73	Flow . . . 5.3 cfs BOD_5 . . . >48 TSS . . . 50	pH . . . . . 6.5 S.U. Fecal coliforms . . 1600/100 ml Total coliforms . . 880,000/100 ml
White Sulphur Springs (9N6E13CAC)	Lagoon	S. Fork Smith River	MT 0020699	Continuous	3/1/73	Flow . . . 0.1 cfs BOD_5 . . . 16	Total coliforms . . 230,000/100 ml
East Helena (10N3W24DCA)	Lagoons	Prickly Pear Cr.	MT 0022560	Continuous	11/29/73	Flow . . . 0.68 cfs BOD_5 . . . 12 TSS . . . 20	pH . . . . . 6.5 S.U. Fecal coliforms . . 9,000/100 ml Total coliforms . . 48,000/100 ml
Fairfield (22N3W33B)	Lagoon	Greenfields Lake	MT 0020290	Continuous	4/11/74	Flow . . . 0.1 cfs BOD_5 . . . 31	Fecal coliforms . . 400/100 ml
Townsend (7N2E30DBC)	Lagoon	Missouri River	MT 0020508	Continuous	4/6/74	Flow . . . 0.7 cfs BOD_5 . . . 9	Total coliforms . . 12,000/100 ml

(1) See Appendix C.
(2) STP - Sewage treatment plant.
(3) WTP - Water treatment plant.

TABLE 9. CHARACTERISTICS OF SIGNIFICANT INDUSTRIAL DISCHARGES

WASTE SOURCE[1] AND LOCATION	WASTE SOURCE IDENTIFICATION DATA: TREATMENT TYPE	RECEIVING WATER	DISCHARGE PERMIT NO.	DISCHARGE TYPE	DATE SAMPLED	DISCHARGE CHARACTERISTICS (Units are mg/l unless otherwise shown.)	
Malmstrom Air Force Base (21N4E35ABB)	Trickling Filter	Missouri River	MT 0020443	Continuous	12/5/73	Flow . . not measured BOD_5 . . . . . 13 TSS 4	pH . . . . . 7.1 Fecal coliforms . . 700/100 ml Residual chlorine . 0.10
Anaconda Co. (Great Falls)							
Discharge 001 (20N4E5BBD)	Trickling Filter	Missouri River	MT 0000493	Continuous	12/5/73	Flow . . . . . 0.03 cfs TSS 6	pH . . . . . 7.8 S.U. Fecal coliforms . . 1/100 ml Residual chlorine . 1.4
Discharge 002 (21N4E32DCC)	NA[2]	Missouri River	MT 0000493	Continuous	12/5/73	Flow . . . . . 9.9 cfs Conductance $\mu\mho$/cm at 25°C 443 SO_4 . . . . . 72 [3] TR Cu . . . . . 7.3 TR Cd . . . . . 0.04 TR Zn . . . . . 1.5 TR As 0.01	pH . . . . . 8.10 Temp. °C . . 17.0 TSS . . . . 40 Oil & Grease 1 TR Fe. . . . 0.60 TR Pb . . . <0.01 TR Mn . . . 0.15
Discharge 003 (21N4E32DCB)	NA	Missouri River	MT 0000493	Continuous	12/5/73	Flow . . . . . 0.05 cfs Conductance $\mu\mho$/cm at 25°C 443 SO_4 . . . . . 315 TR Cu . . . . . 0.20 TR Cd . . . . . 0.10 TR Zn . . . . . 22 TR As 0.04	pH . . . . . 7.5 Temp. °C . . 2.5 TSS . . . . 35 Oil & Grease <0.9 TR Fe. . . . 0.08 TR Pb . . . <0.01 TR Mn . . . 6.8 TR Al . . . 4.2

(1) See Appendix C.
(2) NA - not applicable.
(3) TR - Total Recoverable.

WASTE SOURCE[1] AND LOCATION	WASTE SOURCE IDENTIFICATION DATA: TREATMENT TYPE	RECEIVING WATER	DISCHARGE PERMIT NO.	DISCHARGE TYPE	DATE SAMPLED	DISCHARGE CHARACTERISTICS (Units are mg/l unless otherwise shown.)	
Discharge 004 (20N4E5BAC)	NA[2]	Missouri River	MT 0000493	Continuous	12/5/73	Flow . . . . . 0.09 cfs Conductance µ℧/cm at 25°C 449 SO_4 . . . . . 72 TR Cu . . . . . 0.01 TR Cd . . . . . <0.01 TR Zn . . . . . 0.25 TR As 0.01	pH . . . . . 8.10 Temp. °C . . 9.0 TSS . . . . 12 Oil & Grease <0.9 TR Fe . . . 0.09 TR Pb . . . <0.01 TR Mn . . . 0.05
Discharge 005 (20N4E5BAD)	NA	Missouri River	MT 0000493	Continuous	12/5/73	Flow . . . . . 0.43 cfs Conductance µ℧/cm at 25°C . 495 SO_4 . . . . . 178 TR Fe . . . . . 2.4 TR As 0.52	pH . . . . . 7.40 Temp. °C . . 21.5 TSS . . . . 66 Oil & Grease <0.9 TR Cu . . . 2.5
Phillips Petroleum Company (20N3E1ABD)	Aerated Lagoons	Missouri River	MT 0000434	Continuous	12/5/73	Flow . . . . . 0.25 cfs Oil & Grease . . 6 Total Phenol . . 0.010 NH_3-N 13	Temp. °C . . 2.0 BOD_5 . . . . 9 TSS . . . . 28 COD 78
Ayrshire Dairy (20N3E25BAC)	Lagoons	Missouri River	MT 0001074	Continuous	12/6/73	Flow . . . . . 1 gpm Conductance µ℧/cm at 25°C 2186 COD . . . . . 500 PO_4 . . . . . 40 BOD_5 . . . . . >48 Fecal coliforms 2000/100 ml	pH . . . . . 8.00 Temp. °C . . 1.0 TSS . . . . 85 NO_3 . . . . 2.5 NH_3-N . . . 23 Total Phosphate . . 62
ARSARCO Lead Smelter (10N3W36AAB)	NA	Prickly Pear Cr.	MT 0000345	Continuous	12/4/73	Flow . . . . . 4.6 cfs Conductance µ℧/cm at 25°C 283 SO_4 . . . . . 20.0 TR Pb . . . . . 0.13 TR Mn . . . . . 0.10 TR Cu . . . . . 0.03 COD 3.3	pH . . . . . 7.9 Temp. °C . . 19.0 TSS . . . . 1.0 TR Ag . . . <0.01 TR As . . . <0.01 TR Zn . . . 0.22 TR Cd . . . <0.01

(1) See Appendix C.
(2) Not applicable.

WASTE SOURCE[1] AND LOCATION	WASTE SOURCE IDENTIFICATION DATA: TREATMENT TYPE	RECEIVING WATER	DISCHARGE PERMIT NO.	DISCHARGE TYPE	DATE SAMPLED	DISCHARGE CHARACTERISTICS (Units are mg/l unless otherwise shown.)			
Zinc Fuming Furnace (10N3W36ADB)	NA[2]	Prickly Pear Cr.	MT 0000345	Continuous	12/4/73	Flow	12.0 cfs	pH	7.7
						Conductance /cm at 25°C	293	COD	43.
								Temp. °C	29.0
						TSS	4.0	SO_4	75
						TR Cu	0.03	TR Cd	<0.01
						TR As	0.01	TR Ag	<0.01
						TR Pb	0.13	TR Cu	0.03
						TR Mn	0.14	TR Zn	0.23
Giant Springs Fish Hatchery (21N4E33ACB)	None	Missouri River	MT 0000990	Continuous	12/5/73	Flow	1.1 cfs	pH	8.00
						Conductance /cm at 25°C	634	Temp. °C	12.0
								TSS	2
						NO_3	0.13	Total Phosphate	0.13
						Ortho Phosphate	0.13		
						BOD_5	<1	Fecal Coliforms	<1/100 ml
Great Falls Meat Company (21N4E34BCB)	Lagoons	Missouri River	None	Continuous	12/5/73	Flow	0.04 cfs	COD	168
						NO_3	1.6	Ortho Phosphate	3.3
						Total Phosphate	7.2		
						Fecal Coliforms	40/100 ml		

(1) See Appendix C.
(2) Not applicable.

Helena Sewage Treatment Plant

Present treatment processes include grit removal, screening and grinding, primary sedimentation, heated digestion and gravity dewatering, and chlorination of the primary effluent before discharge to Prickly Pear Creek. Average daily flow in 1972 was 2.8 mgd. Flows greater than 6 mgd are bypassed (Northwest Planners, 1971 and Morrison and Maierle, 1972).

Improvements to the present primary plant will consist of upgrading primary treatment and providing secondary treatment. A redwood media trickling filter will be used to achieve secondary treatment. Average daily flow for the 1990 design year is 4.5 mgd. Peak flow for the 1990 design year is 22 mgd without surface water exclusion and 6 mgd with stormwater exclusion.

Helena Water Treatment Plant

This municipal facility provides water for domestic consumption by treating Missouri River water. Treatment consists of coagulation, flocculation, sedimentation, filtration and disinfection. All filter backwash and sedimentation basin overflow is discharged to two parallel settling ponds. The ponds have been sized to provide 100 percent disposal by evaporation. Provision has been made for overflow to Prickly Pear Creek (Public Notice MT-73-018).

Belt

Sewage treatment facilities at Belt consist of a two-cell facultative lagoon system. Each cell has a surface area of approximately 3.4 acres. The cells are operated in parallel and discharge intermittently to Belt Creek. Estimated BOD_5 discharged is 20 pounds per day. The lagoon system is designed for a population of 680. Belt experienced a decrease in population of 13.3 percent between 1962 and 1972. The present system is assumed adequate for several years (Water Pollution Control in Cascade County, 1972).

Cascade

Sewage Treatment facilities at Cascade consist of a two-cell facultative lagoon system constructed in 1961 on an island in the Missouri River. Each cell has a surface area of approximately 4.0 acres. Only one cell has been used with infrequent discharge to the Missouri River. Estimated BOD5 of the discharge is 20 pounds per day. Cascade gained 18.2 percent in population between 1962 and 1972. Substantial growth in Cascade probably will continue. The system was

expected to be adequate until 1982 (Water Pollution Control in Cascade County, 1972).

Vaughn

The community of Vaughn has two sewage systems, both of which are inadequate. The original townsite was set up as a rural improvement district under jurisdiction of the Board of County Commissioners and serves about 200 people. Treatment is provided by an Imhoff tank (primary treatment), which then discharges to Muddy Creek. The Imhoff tank has deteriorated structurally; plus, it does not provide a minimum of secondary treatment as required by Montana water quality standards. There are many homes adjacent to the Vaughn community system being served by septic tanks and drainfields, most of which do not function properly due to tight soil conditions.

The second system serves Big Sky Vista Subdivision and consists of a collection system, lift station and one-half acre, non-overflowing lagoon cell. The entire sewage flow to this cell is being disposed of through seepage and evaporation. Three problems with this system need corrective action.

1. The present lagoon system is undersized and cannot provide adequate treatment for the subdivision when fully developed.

2. A major problem and health hazard to the residents of the Big Sky Vista has been the backup of sewage into basements. The cause is twofold. First, the single pump lift station operates without standby power; and second, no provision was made in the collection system to screen out large articles that could render the pump inoperative. The lift station was originally designed as a single submersible pump housed in a pre-cast wet well. The actual unit installed was a single-chambered air ejector. The pump discharge line broke near the receiver approximately one year ago, and sewage was discharged equally to the ground surface and the lagoon during the discharge cycle. This has been temporarily repaired; however, several improvements are required to make this a reliable lift station.

3. The collection system is partially obstructed by sediment and could have major structural failures in some areas. The district plans to have these lines cleaned and possibly inspected by video.

To solve the sewage treatment disposal needs of the original townsite and Big Sky Vista, the Vaughn sewer district was formed. The project proposed for the district consists of an interceptor sewer to consolidate sewage produced by both Big Sky Vista Subdivision and the community of Vaughn, provide improved treatment facilities and provide sewage collection facilities for residences not presently served by the existing community systems. The district boundary is flexible, and much land not presently within the district is serviceable by the system. It is anticipated that the system design will be adequate for the area for at least 20 years.

The treatment system will consist of an aerated lagoon cell, plus one or two polishing ponds. At the present time, it is proposed to discharge disinfected effluent from this system to a backwater channel of the Sun River. No problems should be created by discharging to this backwater channel. If future treatment requirements dictate that the system must be upgraded, irrigation of nearby pasture land with the lagoon effluent is a possibility as well as provision of a seepage lagoon cell. The project was bid on March 5, 1974 and is under construction.

Sand Coulee, Tracy and Stockett

A single sewerage system for Tracy and Sand Coulee has been recommended. Present disposal is mainly by septic tank and subsurface disposal, but some individual sewers discharge to natural drainages in the area. Preliminary engineering design presently is being completed for a sewerage and treatment system at Stockett. Creek waters in this area are degraded from acid mine drainage from abandoned coal mines. It appears improbable that growth will be experienced in these communities unless public sewerage systems and elimination of acid mine drainage are provided.

East Helena

Sewage treatment for East Helena is provided by two 7-acre facultative lagoon cells operated in series. Operating depth is five feet. This system is overloaded hydraulically by infiltration during summer months. As much as 1,000,000 gallons of infiltration water per day may be entering the system during the irrigation season. Effluent from the lagoon cells is discharged to adjacent land and eventually seeps away. Most of the effluent is used for irrigating adjacent land in the summer. Flows recorded by the Department of Health and Environmental Sciences have varied between 0.15 cfs and 0.3 cfs. Definite wastewater treatment needs are difficult to ascertain because of infiltration and

uncertainty as to future growth within the town. However, Wirth and Mueller (Vol. 8, 1970) estimated that an additional 12 acres of lagoon will be needed by 1980. The Department of Health and Environmental Sciences has been monitoring the discharge from the lagoon system since mid-1972. Information obtained will be used as a guide to outline future treatment needs.

Fairfield

A single 10-acre lagoon with an operating depth of five feet provides adequate sewage treatment. Effluent from the lagoon is discharged to Freezeout Lake via an irrigation canal. The rate of discharge is unknown. The 1970 population of the community was 638. By 1990, the population is expected to reach 1,070. The existing sewage treatment lagoon should be sufficient through 1990 (Comprehensive Areawide Water and Sewer Plan, Vol. 2, 1970). However, Wirth and Mueller (Vol. 2, 1970) estimated the 1970 population at 905, a significant over-estimate. Therefore, the 1990 estimate of 1,070 probably is too great also.

Townsend

Present sewage treatment for Townsend is inadequate. Infiltration problems, particularly during the summer irrigation season, cause the existing 16.5-acre, single-cell lagoon of five-foot depth to be overloaded hydraulically. Community population is expected to reach 1,900 by 1975 and 2,500 by 1990. An additional five acres of lagoon will serve adequately the needs of the community if infiltration problems are corrected (Mueller and Wirth, Vol. 8, 1970). The Department of Health and Environmental Sciences has been monitoring the discharge from the lagoon system since mid-1972. Flows have varied from 0.2 to 0.7 cfs. Information obtained will be used as a guide to outline future treatment needs.

Fort Benton

Sewage treatment facilities at Fort Benton consist of a two-cell facultative lagoon system. Surface area of each cell is about 10.5 acres. However, only one cell is in use. Effluent from this cell is discharged to the Missouri River. Flows are estimated to be about 0.2 cfs. Coliform densities, BOD_5 and total suspended solids in the discharge have been high. The Department of Health and Environmental Sciences has recommended the second cell be placed in series operation. Mueller and Wirth (Vol. 9, 1970) recommended modification of the collection system to exclude substantial stormwater flows. The 1990 population is estimated to be 2,485. Treatment improvements will probably be needed to meet minimum treatment requirements and the population increase.

Fort Benton Water Treatment Plant

This facility provides water for domestic consumption by treating Missouri River water. Treatment consists of coarse screening, coagulation, flocculation, sedimentation, filtration and disinfection. A single outlet to the Missouri River discharges without treatment filter backwash plus sedimentation overflow and flushing water. Sanitary wastes from this facility are discharged to the city's sewer system (Public Notice MT-73-018). No estimate of flow was available.

Power Water Treatment Plant

This is a small municipal potable water treatment plant which serves 50 users. Treatment includes primary sedimentation, chemical coagulation, flocculation, settling, and filtration and disinfection. Filter backwash is discharged to the primary settling basin. The settling basin overflow is discharged to Muddy Creek directly south of the water treatment plant. No sanitary wastes are discharged. Estimated flow from this plant is 925 gpd (Public Notice, November 21, 1973).

Highwood

Present disposal of domestic wastewater is mainly by septic tank and subsurface disposal. However, some individual sewers discharge to Highwood Creek. Construction of the central collection system and waste treatment facilities is scheduled for summer, 1974. Waste treatment facilities will consist of a 25,000 gpd activated sludge plant followed by a single-cell, 0.17-acre polishing pond. Normal operating depth and detention time for the pond are five feet and 7.5 days, respectively. Effluent from the mechanical plant will be chlorinated. Effluent from the polishing pond will be discharged continuously to Highwood Creek (Thomas, Dean and Hoskins, July, 1973).

Augusta

A single-cell, five-acre lagoon provides wastewater treatment for Augusta. The facility is reported to discharge occasionally to an adjacent ditch. It is not known if the effluent reaches Elk Creek. Secondary treatment can probably be met with an additional lagoon cell to contain the overflow.

Mountain View School

Two series operated, three-quarter acre facultative lagoon cells provide adequate treatment at the school. The

second cell has not discharged so disposal is by seepage and evaporation.

INDUSTRIAL DISCHARGES

There are 30 known industrial discharges in the basin. Sixteen of these are in the Great Falls vicinity with eight in the vicinity of Helena. Discharges associated with the metal refining industry are centered around Anaconda Company operations in Great Falls. Non-contact cooling water discharges occur at Trident, East Helena and Montana City. Phillips Petroleum at Great Falls is the only refinery in the basin. Domestic wastewater from the industrial facilities is considered an industrial discharge for purposes of this report.

Alhambra Manor Nursing Home

Sewage treatment facilities consist of a 15,000 gpd extended aeration package treatment plant followed by a small holding pond of about 100,000 gallon capacity. Effluent from the package plant is chlorinated before discharge to the holding pond. Effluent from the holding pond enters Prickly Pear Creek above its junction with Warm Springs Creek. A vee-notch weir provides flow measurement (Stahley and Harrington, 1971).

National Cylinder Gas Company

This company produces compressed oxygen and nitrogen. Atmospheric air is filtered and compressed; temperature is reduced by refrigeration and expansion. The air is then separated into oxygen and nitrogen by distillation. Non-contact cooling water is the only discharge from this facility. Cooling water is obtained from Prickly Pear Creek and returned to Prickly Pear Creek through a single structure. The discharge enters Prickly Pear Creek approximaely two-thirds mile south (upstream) from U. S. Highway No. 287 bridge in East Helena. Estimated average flow, pH and temperature of the discharge are 1.08 mgd, 7.5 and 50° F, respectively (NPDES Permit Application MT 0000426).

Anaconda Company, Great Falls

This facility produces electrolytically refined copper, copper billets, rods and wires, and aluminum wire. Primary refined copper anodes are obtained from the company refinery at Anaconda, Montana; and aluminum billets come from company facilities in Columbia Falls, Montana. Zinc

refining operations in Great Falls were terminated in 1973. A two-year project to remove the zinc facilities was started this spring.

Five discharges exist at this plant. Discharge 001 contains sanitary wastes from the plant and residence area which have been treated in a trickling filter package plant. Discharges 002 and 005 are from the copper operation, and discharge 003 is from the aluminum operation. Discharge 002 is a combination of sanitary wastes from the eastern portion of the mill which have passed through a treatment lagoon, overflow from the cooling ponds, and pickling rinse. Discharge 003 and 005 both include overflow from the cooling ponds. Discharge 004 carries surface water runoff and infiltration and will be eliminated in the near future. Appropriate parameters for each of the discharges are summarized in Table 10. All five discharges are to the Missouri River. Discharge 001 is located approximately 200 yards downstream of Black Eagle Dam on the Missouri River. Discharges 003, 004, 005 and 002 are located at approximately 200-yard intervals downstream of discharge 001 (NPDES Permit Application MT 0000426).

TABLE 10. DESCRIPTION OF ANACONDA COMPANY (Great Falls) DISCHARGES(1)

(Anaconda Company data from NPDES Permit Application MT 0000426)

Parameter	Average	Maximum
Discharge 001		
Flow	43,000 gpd	55,000 gpd
BOD5	12 mg/l	15 mg/l
Settleable Solids	Trace	0.2 mg/l
Chlorine Residual	1.2 mg/l	2.4 mg/l
Discharge 002		
Flow	4.7 mgd	7.2 mgd
pH	7.8	8.5
Lead	0.01 mg/l	0.02 mg/l
Copper	1.7 mg/l	6.3 mg/l
Iron	0.04 mg/l	0.06 mg/l
Cadmium	0.15 mg/l	0.25 mg/l
Arsenic	0.0009 mg/l	0.013 mg/l
Manganese	0.5 mg/l	0.8 mg/l
Zinc	4.2 mg/l	21.0 mg/l
Total Suspended Solids	23 mg/l	59 mg/l
Oil and Grease	0.6 mg/l	0.8 mg/l

Parameter	Average	Maximum
Discharge 003		
Flow	0.1 mgd	0.15 mgd
pH	7.6	8.0
Lead	0.01 mg/l	0.01 mg/l
Copper	0.3 mg/l	0.5 mg/l
Iron	0.2 mg/l	1.1 mg/l
Cadmium	0.34 mg/l	0.79 mg/l
Arsenic	0.008 mg/l	0.014 mg/l
Manganese	10.0 mg/l	46.6 mg/l
Zinc	36.2 mg/l	315 mg/l
Aluminum	0.1 mg/l	3.1 mg/l
Total Suspended Solids	37 mg/l	140 mg/l
Oil and Grease	1.1 mg/l	2.0 mg/l
Discharge 004		
Flow	0.07 mgd	0.010 mgd
Lead	0.10 mg/l	0.38 mg/l
Copper	0.2 mg/l	0.4 mg/l
Iron	0.9 mg/l	2.6 mg/l
Cadmium	0.21 mg/l	0.55 mg/l
Arsenic	0.033 mg/l	0.053 mg/l
Manganese	0.3 mg/l	0.7 mg/l
Zinc	9.0 mg/l	17 mg/l
Total Suspended Solids	28 mg/l	38 mg/l
Discharge 005		
Flow	0.47 mgd	0.5 mgd
pH	7.5	8.1
Copper	1.6 mg/l	6.9 mg/l
Iron	0.9 mg/l	2.1 mg/l
Nickel	0.7 mg/l	3.6 mg/l
Arsenic	0.048 mg/l	0.13 mg/l
Total Suspended Solids	27 mg/l	78 mg/l
Oil and Grease	1.0 mg/l	1.8 mg/l

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(1) Existing discharge characteristics

Phillips Petroleum

Motor fuel, jet fuel, No. 1 stove oil, diesel fuel, asphalts, and No. 5 burner fuel oil are manufacturered at this refinery. Process water is discharged to the Missouri River after passing through an air flotation separator followed by a two-cell lagoon system. The first cell is surface aerated. Discharge characteristics are summarized in Table 11 (NPDES Permit Application MT 0000434).

TABLE 11. PHILLIPS PETROLEUM DISCHARGE CHARACTERISTICS[1]

(Phillips Petroleum data from NPDES Permit Application MT 0000434)

Parameter	Average	Maximum
Flow	0.15 mgd	0.30 mgd
Temperature	80° F	85° F
pH	6.5	9.0
BOD_5	36 lbs/day	60 lbs/day
COD	377 lbs/day	1,167 lbs/day
Total Suspended Solids	6 mg/l	12 mg/l
Phenols	0.08 mg/l	0.16 mg/l
Oil and Grease	6 mg/l	18 mg/l
Total Chromium	0.05 lbs/day	0.10 lbs/day
Sulfide	0 lbs/day	0.lbs/day
Ammonia	23 lbs/day	47 lbs/day

(1) Existing discharge characteristics.

Ayrshire Dairy

The dairy is a family-owned corporation engaged in the production, processing and distribution of fluid milk and the distribution of some manufactured dairy products. The application is for a discharge which consists of cooling water, minor volumes of waste skim milk, miscellaneous process wastes and sanitary sewage from five residences. All wastewater is treated in a two-cell anaerobic-facultative lagoon system prior to storage and subsequent irrigation of adjacent agricultural lands.

Ideal Cement Company, Trident

Approximately 940 tpd (tons per day) of portland cement are manufactured at this plant by the non-leaching wet process. About 50 gpm of non-contact equipment cooling water is discharged to the Missouri River. Temperature of the discharge is estimated to be 4° F above the ambient river temperature. Cooling water is obtained from the Missouri River.

A second discharge consists of treated domestic wastewater from the plant and the company community of Trident. A 5,000 gpd extended aeration plant adequately serves the plant and present community population of 40. Chlorinated effluent is discharged to the Missouri River at the rate of 60 gpm for about one hour each day. The existing sewage

treatment plant will serve the needs of the plant and community for the foreseeable future.

American Smelting and Refining Company

This plant, located at East Helena, Montana, is a custom smelter producing pig lead, zinc and a benefitted spiess for further refining at other locations. Zinc is recovered from waste gases of the lead smelter. Both discharges from American Smelting operations are non-contact cooling water obtained from Prickly Pear Creek. Water from the furnace jacket of the lead smelter is returned to Prickly Pear Creek after passing beneath the slag dump. Zinc fuming furnace cooling water is discharged to a five-acre storage and supply pond where it is cooled prior to reuse. Characteristics of the discharge to Prickly Pear Creek are summarized in Table 12.

TABLE 12. AMERICAN SMELTING AND REFINING COMPANY COOLING WATER DISCHARGE CHARACTERISTICS

(Data from Permit No. MT 0000345)

Parameter	Average	Maximum	Minimum
Flow	2.09 mgd	2.96 mgd	-
Temperature			
Summer	76° F	88° F	53° F
Winter	46° F	66° F	44° F
pH (S.U.)	7.8	7.8	7.8

Kaiser Cement Company

Approximately 890 tpd of portland cement are manufactured by the non-leaching wet process by this plant at Montana City, Montana. Discharge 001 is non-contact cooling water used primarily to cool bearings and shafts. Average flow is 15 gpm. Average summer and winter temperatures are 70° F and 40° F, respectively (Permit No. MT 2SB OXT 2 000324). Discharge 002 is seepage water below a process water seepage and evaporation pond. Seepage flow is about 15 gpm with pH between 10 and 11. Slurry water from the wet process, plus other process wastes and scrubber water, make up the waste flow to the pond. Discharge 002 is combined with discharge 001 before entering nearby Prickly Pear Creek.

Burlington Northern

This facility at Great Falls provides maintenance and service for rail cars and diesel engines. The power plant boiler is shut down and is not expected to be operated again. The remaining discharge includes floor drainage from the shops, water storage tank overflow, and minor storm runoff from the yard which pass through the sand and oil trap prior to discharge. Both discharges flow into the Missouri River (Public Notice MT-73-027).

Malmstrom Air Force Base

Malmstrom is a major U. S. Air Force installation whose activities support the minuteman missile program. Storm runoff, minor miscellaneous wastes from car wash racks, boiler blowdown, and shop floor drains are discharged via a single outlet to an unnamed coulee and thence into the Missouri River. Estimated flow of this discharge is 50,000 gpd (Corps of Engineers Permit Application No. MT 2SB OXT 2 00714). Chlorinated wastewater from the base sanitary sewage treatment plant is discharged to the Missouri River about 100 feet upstream of the above-unnamed coulee. A 750,000 gpd high rate trickling filter plant serves the present base population of 11,000 (NPDES Permit Application No. MT 0020443).

Giant Springs Fish Hatchery

The Department of Fish and Game maintains this facility for hatching and rearing rainbow trout. Approximately 50,000 pounds of trout are produced annually. Water for operation of the hatchery is diverted from Giant Springs and discharged to the Missouri River. The hatchery is about one mile downstream of the Great Falls city limits. Suspended solids from unused food and feces, increased biochemical oxygen demand and increased nutrient levels typify hatchery effluents (Public Notice MT-73-015). No estimate of average flows is available.

Placer Gold Mining Company

Water for operation is diverted from Indian Creek (east of Townsend, Montana) to separate free gold from the alluvium. Wastewater is then discharged to a series of settling ponds for removal of suspended solids before finally returning to Indian Creek. Average and maximum flows are estimated to be 120,000 to 180,000 gpd. The placer is worked approximately 120 days per year, eight hours per day by two men. This permit has not been renewed; thus, the operation is assumed inactive (Montana State Permit 61-W-1).

Great Falls Meat Company

Approximately 750 cattle and 1,500 hogs are slaughtered and processed weekly. Wastewater from the firm contains slaughter and process wastes plus sanitary wastes from approximately 80 workers (Montana State Permit 10-W03). A two-cell series operated lagoon system treats the wastewater before discharge to the Missouri River via an unnamed coulee. Surface areas and operating depths of both cells are one acre and ten feet, respectively (Wenzel, 1963). Effluent from the lagoon system was disposed of by irrigation of adjacent lands. However, the distribution system has failed.

Canyon Ferry - Bureau of Reclamation

Sewage treatment at the powerhouse is by a 500 gpd Yeoman extended aeration plant. Effluent is discharged to the Missouri River. Present workforce at the powerhouse consists of 12 men working eight-hour shifts during the week and the equivalent of one man working 24 hours per day on weekends. Estimated flow during the week is 180 gpd. So, the plant is loaded lightly.

Sewage treatment for the townsite consists of an Imhoff tank, dosing siphon, trickling filter, secondary settling tank with sludge return to the Imhoff tank and an outfall line to the river. Treatment facilities are designed for 250 persons. About 10 gpm of clarified effluent is added to the dosing chamber for the trickling filter. The trickling filter is enclosed and heat lamps are used to permit year-round operation. Bureau of Reclamation personnel have noted flows from 4,000 to 8,000 gallons per day. An average of 5,000 gallons per day is assumed. No means of flow measurements are provided. However, a small vee-notch weir could be installed at the secondary settling tank.

Montana Power Generating Stations

Montana Power Company maintains seven generating stations in the basin, all of them located along the mainstem of the Missouri River. Each of the installations uses water power for generation. Small extended aeration package plants are used for sewage treatment at all of the power plants. A variety of sewage treatment methods are used to treat wastewater from on-site employee housing.

Hauser Dam. Sewage treatment at Hauser Dam consists of four separate systems. A 600 gpd Bio-Pure extended aeration unit is used at the powerhouse. The aeration unit

fills to a selected depth and some of the aerated liquid is transferred to the clarifier. After a selected time period, the clarified liquid is then pumped to a chlorine contact tank, and the settled sludge is returned to the aeration compartment. The liquid remains in the chlorine contact tank for a selected time period and is then discharged to the river. Sludge from the contact tank is returned to the aeration compartment. The powerhouse is staffed with three men working an eight-hour per day shift during the week. A second Bio-Pure extended aeration plant serves the service shop. Operation is similar to the powerhouse unit. Effluent is discharged to the reservoir near the powerhouse intake. Only occasional use is made of the shop.

An Emico extended aeration plant serves housing along the east side of the reservoir. Only two homes with two persons each were occupied on November 29, 1973. Discharge from the clarifier is to Hauser Lake approximately 200 yards above the dam. Three homes on the west side of the river below the dam are served by a small sewage lagoon. The lagoon is about 50 feet by 30 feet and about five feet deep. There is no overflow from the lagoon. Some odor is noted in the early spring.

Holter Dam. The Holter plant is staffed by a three-man crew. Sewage treatment facilities consist of a 500 gpd Bio-Pure unit installed in 1971. The camp at Holter consists of 11 houses, five being occupied full-time. Sewage facilities consist of a new septic tank and drainfield installed in 1969 (Montana Power, 1974).

Rainbow Dam. The Rainbow plant is a fully-manned operation with electrical dispatch. The plant is operated by 10 to 25 personnel. The plant is equipped with a 600 gpd Bio-Pure unit installed in 1971. The camp at Rainbow has 11 residences and a four-apartment clubhouse served by a 5,700 gpd Bio-Pure unit. Approximately 40 to 45 people live in camp. The Bio-Pure at the Rainbow camp was installed in 1971 (Montana Power, 1974).

Black Eagle Dam. Black Eagle Dam is operated full-time by seven personnel. Sewage treatment facilities consist of a 600 gpd Bio-Pure unit installed in 1971. There is no camp housing at Black Eagle Dam.

Ryan Dam. Ryan Dam is a semi-automatic facility operated full-time by five personnel. Ryan is served by a Bio-Pure 600 gpd waste treatment facility at the plant installed in 1971. The locations at the Ryan Dam, called Upper and Lower Camps, consist of eight and three residences, respectively.

Septic tanks and drainfield installations installed in 1971 serve to treat the wastewater discharged from these houses (Montana Power, 1974).

Morony and Cochrane Dams. Morony Dam and Cochrane Dam are fully automated operations without camp housing and no full-time personnel. Each dam has one man working half a day, and toilet facilities are required under OSHA. However, no treatment facilities are felt to be necessary at these plants (Montana Power, 1974).

All of the Bio-Pure plant treatment units operated by Montana Power contain chlorination equipment capable of treating wastes for a minimum of 90 minutes. Daily flows vary considerably at each plant based on the number of men on the job during the day. Daily water flow figures are not available. However, the capability of the Bio-Pure units to treat wastewater is well within any maximum heavy flow occurrences for each site.

AGRICULTURAL DISCHARGES

A variety of agricultural wastes are present in the Missouri-Sun-Smith basin, including irrigation return flows, animal wastes, runoff from range and cultivated lands and from land treated with pesticides and fertilizers. Although there are a number of potential water quality problems due to agriculture, high nitrates in the Crow Creek drainage and high sediment yields in Muddy Creek have been the only problems identified in this report. Agricultural pollution is transient in both time and space and is complex due to the variability of agricultural practices. The effect of agricultural wastes on water quality generally is difficult to determine without long-term studies. Other than the problems mentioned above, gross agricultural pollution problems in the basin are not apparent. However, the summation effect of the many small agricultural abuses is felt to be significant. Future water quality monitoring and additional basin investigations will assist in quantification of agriculture's role in water quality. Several agricultural waste discharge permit applications for the basin have been received. However, only one of these is listed as having a discharge.

MINING ACTIVITY

Channel changes due to placer mining and the creation of acid seeps high in toxic metals due to hard-rock metal mining have degraded many streams in the Missouri-Sun-Smith

basin. Placer and hard-rock metal mining operations have been most extensive in the Crow, Prickly Pear, Little Prickly Pear and Belt Creek drainages and in the Big Belt Mountain tributaries to Canyon Ferry Reservoir (Plate I). Acid mine seeps from abandoned coal mines in Cascade County continue to degrade Sand Coulee and Belt Creeks. Sand, gravel and rock have been mined for construction purposes in all counties of the basin, but resulting water quality degradations are believed slight and only of a very local nature. Other non-metallic mining in the basin has been minor and is not considered a water pollution problem.

Broadwater County

Gold has been the mainstay of metal mining in Broadwater County since its discovery in Confederate Gulch in 1864. Placer mining soon spread into nearby White, Avalanche, Hellgate and Magpie Gulches. Further placer gold prospecting lead to the discovery of lode deposits in Crow, Indian and Beaver Creek drainages (Water Resources Survey, Broadwater County, June, 1956). According to Helena National Forest officials (May 5, 1973), acid drainage and sediment pollution due to mining activity generally is slight in Broadwater County. However, some sediment transport probably can be associated with placer mining.

Confederate Gulch Area. This area, located on the western slopes of the Belt Mountains, is northeast of Winston in the extreme northeastern portion of the county (Plate I). It includes the placer mining areas of Confederate, White, Avalanche and Hellgate Gulches plus the upper extremity of Magpie Gulch. Galena and pyrite are associated with gold ore deposits in Confederate Gulch and result in some acid mine drainage. High turbidities due to placer mining have been reported.

Park (St. Louis, Indian Creek, Townsend) District. The Park District is west of Townsend in the area drained by Indian Creek and its tributaries. Placer mining began in 1870 followed by lode mining. Gold has been the major metal produced, mainly from lode mines (Water Resources Survey, Broadwater County, June, 1956). A state industrial waste discharge permit was issued to Placer Gold Mining Company in 1972. The permit has not been kept current, and the operation is assumed inactive. Helena National Forest personnel (May 5, 1973) reported some drainage from the Park (Park-New Era) Mine. Quality of this discharge is unknown. Even during spring runoff, Indian Creek reportedly loses its entire flow due to channel seepages.

Radersburg (Cedar Plains) District. Radersburg is about ten miles west of Toston in a semi-arid, mountainous area. Placer mining began in the 1860's followed by lode mining in the 1870's (Water Resources Survey, Broadwater County, June, 1956). The area is drained by Crow Creek, a moderate sized stream, which is diverted entirely for irrigation during summer months. Several samples of Crow Creek and its tributaries have been collected by the Water Quality Bureau personnel. Acid drainage or sediment problems resulting from mining activities were not indicated. However, high iron concentrations were noted.

Winston (Beaver Creek) District. The Winston District extends southwest about eight miles from Winston, a station on the Burlington Northern railroad, 20 miles southeast of Helena, Montana. It is in a well-timbered, mountainous area ranging in elevation from 4,500 feet to 8,000 feet. The first lode was discovered in 1867 but systematic mining did not begin until about 1889. Gold was the chief metal in the oxidized ores, but sulphide ores were valued more for their silver-lead content. Zinc is abundant and copper is present in appreciable amounts (Water Resources Survey, Broadwater County, June, 1956). Helena National Forest staff (May 5, 1973) report some mine drainage probably is present, but it is believed insignificant. Samples analyzed in 1973 do not reflect acidity, heavy metals, or sediment problems from mining activity. Beaver Creek is diverted completely for irrigation during summer months.

Jefferson County

The Wickes-Corbin-Gregory (Colorado) District is 20 miles south of Helena. Silver was the major produced metal, followed by gold, lead, copper and zinc (Water Resources Survey, Jefferson County, June, 1956). According to Traynor (1969), the Alta Mine is the major source of acid mine waters debauching to Prickly Pear Creek via Spring Creek. However, several acid mine seeps of lesser magnitude appeared evident but were not investigated. Traynor (1969) found trout populations in Prickly Pear Creek drastically reduced after the entrance of Spring Creek. Maximum observed copper and zinc concentrations in Prickly Pear Creek just below the confluence with Spring Creek were 0.36 mg/l (milligrams per liter) and 20 mg/l, respectively. These concentrations exceed many times the incipient lethal levels for salmonids. According to Sprague, Elso and Saunders (1965), the incipient lethal level of copper is 48 µg/l (micrograms per liter) for salmonids. Incipient lethal level is the concentration at which indications of lethality are first apparent.

Prickly Pear Creek appears to have reached hydraulic stability since being placered. Substantial vegetative growth has re-established itself in most places. So, sediment from past placer activity is not significant. Turbidities summarized in Table 13 appear to substantiate this. However, iron, lead and copper concentrations could affect salmonid growth and propagation. For the June 21, 1973 sample, 60.3 pounds of iron, 20.8 pounds of zinc, 2.08 pounds of copper, and 4.16 pounds of lead passed the gaging station daily. By October, iron, zinc, copper and lead passing the station daily had decreased to 11.66 pounds, 3.64 pounds, 0.73 pounds, and 0.73 pounds, respectively. The difference is due to leaching in the Wickes-Corbin-Gregory area during spring runoff. Traynor (1969) reached a similar conclusion.

TABLE 13. CHEMICAL AND PHYSICAL PARAMETERS FOR PRICKLY PEAR CREEK AT USGS STATION FIVE MILES BELOW CLANCY, MONTANA

Parameter	6/21/73	8/1/73	10/11/73
Flow, cfs(1)	38.0	9.2	
pH	8.2	8.2	8.4
Turbidity, JTU(2)	2	1	1
Specific conductance(3)	183	278	283
(4) TR iron, mg/l	0.29	0.18	0.16
TR zinc, mg/l	0.10	0.06	0.05
TR copper, mg/l	0.01	<0.01	<0.01
TR lead, mg/l	0.02	0.03	<0.01
TR arsenic, mg/l	<0.01	<0.01	<0.01
TR cadmium, mg/l	<0.01	<0.01	<0.01

(1) Cubic feet per second.
(2) Jackson turbidity units.
(3) Micromhos per centimeter at 25° C.
(4) Total recoverable. Samples are preserved with five ml (milliliters) of concentrated nitric acid.

Lewis & Clark County

Metal mining was once the chief industry of the county, which contains eight mining districts. Primary metals produced were gold, silver, copper, lead and zinc (Water Resources Survey, Lewis and Clark County, June, 1957). Metal mining followed the decline of mining in other areas during the 1950's, but rising prices are causing renewed activity. Water pollution due to mining activity in the county is believed slight but is likely to increase with increasing activity.

Cascade County

Mining began in 1876 with the discovery of coal near Belt. Metal mining soon followed with the discovery of silver and lead deposits near Barker in 1879. Similar discoveries were made near Neihart in 1881. By 1888, smelters had been constructed at Neihart, Great Falls and Helena. However, depletion of high-grade ores, plus high shipping costs, eventually forced most of the mines to close. Several brief periods of renewed activity have occurred since 1888 (Water Resources Survey, Cascade County, June, 1961).

Montana (Neihart) District. Most of the mines in this district are in the Carpenter Creek drainage and along the east side of Belt Creek between Neihart and Carpenter Creek. Ore deposits carry a high silver content near the surface, but deeper levels are characterized by decreasing silver and increasing zinc and lead content (Water Resources Survey, Cascade County, June, 1961). Carpenter Creek reportedly has been the source of pollution to Belt Creek in the Neihart area. Welch (April 25, 1960) stated tailings from mine-mill operations in the Carpenter Creek drainage was a primary source of pollution to Belt Creek between 1940 and 1950. With the general curtailment of operations by 1950, sediment ceased to be a major problem (Welch, April 25, 1960).

Heavy metals, leached out under acid conditions, may be a continuing problem in the Montana District. A 1962 fish kill in Belt Creek indicated acid waters with high iron concentrations probably were coming from Carpenter Creek (Welch, August 1, 1960). Unfortunately, chemical data for this period is largely incomplete. Samples collected during April and May of 1967 indicate a metals problem--at least during spring runoff (Table 14). Arsenic was not detected (Chemical Analysis, State Board of Health, June 2, 1967 and February 20, 1968).

TABLE 14. HEAVY METAL CONCENTRATIONS IN CARPENTER CREEK AT CONFLUENCE WITH BELT CREEK

Parameter, mg/l	4/25/67	5/29/67
Iron, TR[1]	0.00	0.72
Zinc, TR	0.20	0.72
Lead, TR	<0.01	0.06
Copper, TR	<0.01	0.12

(1) Total Recoverable

Flows were not measured; so, total loads could not be determined. Reported concentrations are assumed to be total recoverable.

Specific conductance measurements were made at several locations in the Carpenter Creek drainage by Water Quality Bureau staff in 1973. From results summarized in Table 15, workings in the Squaw Creek area are the major source of acid mine waters reaching Carpenter Creek.

TABLE 15. SPECIFIC CONDUCTANCE MEASUREMENTS AT VARIOUS LOCATIONS IN THE CARPENTER CREEK DRAINAGE

Location	Specific Electrical Conductance[1]
Carpenter Creek above Squaw Creek	65
Squaw Creek at mouth	860
Carpenter Creek below Squaw Creek	108

(1) Micromhos per centimeter at 25° C.

Specific conductance measurements of all other Carpenter Creek tributaries ranged between 70 and 246 micromhos per centimeter at 25° C. Mine seeps also occur in Rock Creek and Compromise Gulch, which join Belt Creek at Neihart.

Carbonate (Logging Creek) District. This district, covering an area of about ten square miles, is near the head of Logging Creek about 14 miles northwest of Neihart. Silver and lead are the principal metals in the generally small ore deposits. Only one mine ever produced (Water Resources Survey, Cascade County, June, 1961). Water quality in Logging Creek has not been impaired by mining activity.

Thunder Mountain District. This area, about three miles southwest of Monarch on the north slopes of Thunder Mountain, was prospected for iron ore deposits. No production is recorded (Water Resources Survey, Cascade County, June, 1961). Water pollution problems in the district are believed sight.

Belt, Montana. Coal in the Belt area is in the upper part of the Morrison Formation. Belt and nearby Armington have been noted for coal production since 1876. Largest mine in the area was the Anaconda at Belt (Water Resources Survey, Cascade County, June, 1969). The area has been inspected, and those areas with seeps have been identified and sampled by the Department of Health and Environmental Sciences (Table 16). However, a detailed study of the area is needed.

TABLE 16. ACID MINE DRAINAGE NEAR BELT, MONTANA

Sampling Site	Flow gpm	Date	pH	PARAMETERS (1) As	Pb	Cu	Zn	Fe
East Drain Belt Fill (19N6E26D)	3	2/16/68 (2)	3.5	0.00	0.00	0.00	1.88	450
West Drain Belt Fill (19N6E26C	21	2/16/68 (2)	3.3	0.07	0.00	0.25	3.70	2860
Johnson Mine (19N6E26A)	43	2/16/68 (2)	3.3	0.00	0.09	0.25	7.95	2100
Anaconda Spring (19N6E26D)	100	2/16/68 (2)	3.4	0.00	0.01	0.00	3.80	920

(1) Reported concentrations are assumed total recoverable and are reported in mg/l.

(2) Montana Department of Health Field Investigation (Boland, April 2, 1968).

Sand Coulee Creek. Acid mine waters from abandoned coal mines in this drainage are one of the more serious water pollution problems in the study area. According to McArthur (December, 1970), about 41 mines contribute pollutants periodically and nine contribute continuously. About 25 miles of streams are degraded severely. From samples taken on September 9, 1969, McArthur calculated Sand Coulee Creek with a flow of 1,500 gpm received 6,630 pounds of iron and 26,670 pounds of acidity (as $CaCO_3$) that day. Estimated capital and operating costs for treatment works in 1970 was $612 per day. Because costs were so high, a program of partial treatment plus mine flooding was suggested.

Barker District. This district is discussed under Judith Basin County.

Judith Basin County

Only a small portion of this county lies within the Missouri-Sun-Smith study basin. However, this segment contains most of the Barker District. Activity was centered around the communities of Barker and Hughesville. Mines produced silver and lead with lesser amounts of zinc, copper and gold (Water Resources Survey, Judith Basin County, June, 1963).

The district has been a severe source of water pollution for a number of years. Mines in the area drain into Belt Creek via Galena Creek and the Dry Fork of Belt Creek. The area is the site of a cooperative feasibility study between the EPA (U. S. Environmental Protection Agency) and the Montana Department of Natural Resources and Conservation.

Meagher County

Water pollution due to mining activity in Meagher County is believed slight. Most mining activity occurred prior to 1899 (Water Resources Survey, Meagher County, July, 1950). Helena National Forest representatives (May 5, 1973) stated some placering was occurring in Thompson Gulch and Atlanta Creek, but the effect on water quality was unknown.

Teton, Park, Chouteau and Gallatin Counties

Metal mining in portions of these counties within the study basin has been slight (Water Resources Survey for Teton, Park, Chouteau and Gallatin Counties, Montana, June, 1962; December, 1951; June, 1964 and January, 1953, respectively). So, it is assumed water quality has been little affected by this activity.

NON-POINT SOURCES

Some potential non-point pollution sources have been discussed under agricultural waste discharges. Sedimentation, animal wastes and fertilizers all can create non-point pollution sources. A variety of other non-point pollution sources can exist, including erosion and sedimentation of non-agricultural lands, construction projects and toxic substances or salinity from geological formations in the area. Cultivated lands in the Crow Creek drainage near Toston appear to be a non-point source of nitrate to the Missouri River. A nutrient study of runoff from these and other agricultural lands between Toston and Townsend began in June, 1974 (Section III). No other major non-point sources have been identified in the basin.

VII. SURFACE WATER RESOURCES

The Missouri-Sun-Smith basin contains six major sub-basins (Figure 1 and Plate I). These are Missouri River above Holter Dam, Smith River, Missouri River from Sun River, Dearborn, Sun River and Missouri River from Sun River to Marias River. The Missouri River and its major tributaries in the basin are shown schematically in Figure 3. The U. S. Geological Survey has had 62 stream flow gaging stations in the Missouri-Sun-Smith basin. Twelve of these remain active (Figure 1 and Plate I). U. S. Geological Survey data for gaging stations in the study basin are summarized in Table 17.

Stream flows in the Missouri-Sun-Smith basin are affected by local weather conditions, geology, reservoirs and irrigation (Table 18). A major part of flow occurs during spring runoff. However, spring runoff is a function of weather and precipitation and may be quite variable in both time and volume of runoff. March through early July is the most common snow-melt period, but warm weather in mid-winter can produce significant short-term increases in stream flows. Peak flows from mountain streams, such as Crow and Tenmile Creek, tend to occur from mid-May through early July; whereas, foothill streams, such as Muddy Creek, reach peak stream flows in March. Erratic flows in the Sun River at Simms are attributable to flow regulation at four upstream reservoirs, which store water to irrigate 105,000 acres. Flows in the Missouri River at Toston are affected by upstream diversions for irrigation and reservoir storage. About 555,400 acres of land above Toston are irrigated. There are seven reservoirs on upstream tributaries (USGS Water Resources Data, 1972).

Flows in Muddy Creek markedly increased during the irrigation period of mid-May to fall in 1972. This was also true in 1969, 1970 and 1971 water years. Excess flows from the Greenfields irrigation project are diverted to Muddy Creek (USGS Water Resources Data, 1969, 1970 and 1971).

The pattern of stream flows recorded for the Smith River near Eden, Montana, probably was the result of several factors. The amount of water reaching the mainstem from tributaries is regulated extensively by irrigation usage. Relative utilization of irrigation releases from the Smith

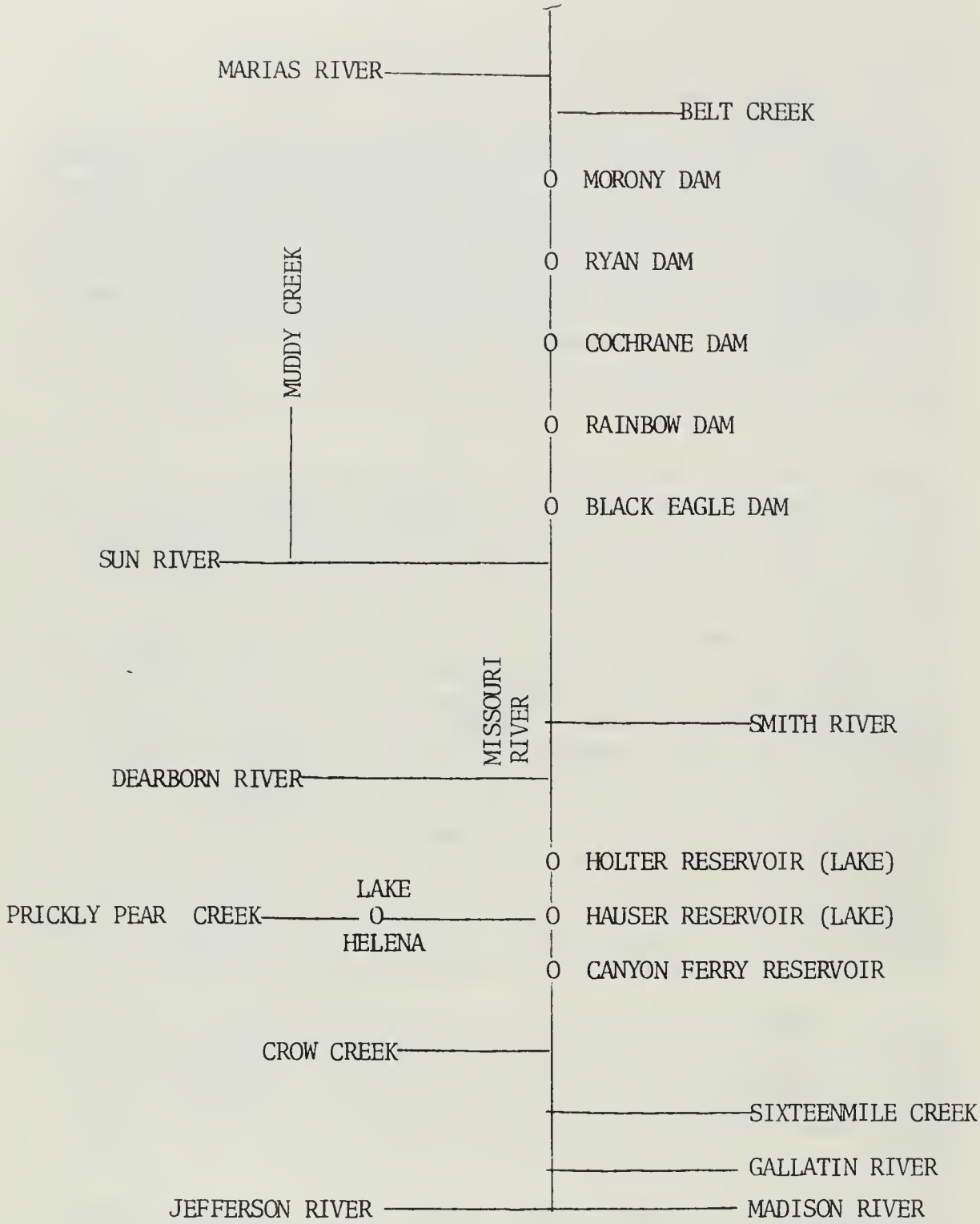


FIGURE 3. SCHEMATIC DIAGRAM OF STREAMS IN THE MISSOURI-SUN-SMITH BASIN

TABLE 17. SUMMARY OF U. S. GEOLOGICAL SURVEY STREAMFLOW GAGING STATION DATA
(PARTIAL RECORD STATIONS NOT INCLUDED)

STATION NAME	USGS STATION NO.	LOCATION[3]	MINIMUM STREAMFLOW (cfs) INSTANTANEOUS	MINIMUM STREAMFLOW (cfs) DAILY	7-DAY, 10-YEAR LOW FLOW (cfs)	AVERAGE ANNUAL FLOW (cfs)	PERIOD OF RECORD
Sixteenmile Creek at Ringling, MT	06053000	6N7E23AA	0	0	not determined	not determined	1950 - 1955
Missouri River at Toston, MT	06054500	5N2E36BD	562	1970	not determined	5310	1890 -
Crow Creek near Radersburg, MT	06055500	6N1W14D	1.4	not determined	not determined	47.7	1919 - 1972[1]
Missouri River near Townsend, MT	79[2]	7N2E30BC	not determined	not determined	not determined	5212	1891 - 1903
Prickly Pear Creek near Clancy, MT	06061500	9N3W23CAD	0.5	not determined	not determined	48.3	1908 - 1969
Prickly Pear Creek at East Helena, MT	88[2]	10N3W36AA	not determined	not determined	not determined	67.5	1908 - 1913
Sevenmile Creek at Birdseye, MT	91[2]	11N4W31D	not determined	0.1	not determined	7.60	1909 - 1913
Dutchman Creek near Alhambra, MT	82[2]	8N3W28CB	0.5	not determined	not determined	not determined	1921 - 1924
Warm Springs Creek at Alhambra, MT	83[2]	8N3W16AB	1.6	not determined	not determined	not determined	1921 - 1924
Clancy Creek at Clancy, MT	84[2]	8N3W9AB	1.0	not determined	not determined	not determined	1921 - 1923

STATION NAME	USGS STATION NO.	LOCATION[3]	MINIMUM STREAMFLOW (cfs) INSTANTANEOUS	DAILY	7-DAY, 10-YEAR LOW FLOW (cfs)	AVERAGE ANNUAL FLOW (cfs)	PERIOD OF RECORD
Lump Gulch Creek at Foley's Ranch near Clancy, MT	85[2]	8N4W1BB	0.06	not determined	not determined	not determined	1921 - 1924
Lump Gulch Creek at Zastrow's Ranch near Clancy, MT	86[2]	8N3W04BB	0.2	not determined	not determined	11.6	1908 - 1913
Tenmile Creek near Rimini, MT	06062500	9N5W20ACB	0.0	0.0	not determined	17.6	1914 -
Tenmile Creek near Helena, MT	0606300	10N4W22A	0	not determined	not determined	27.2	1908 - 1954
Missouri River below Hauser Dam near Helena, MT	94[2]	12N2W29C	not determined	280	not determined	4115	1922 - 1942
Missouri River below Holter Dam near Wolf Creek, MT	06066500	14N3W5DCA	less than 250	747	not determined	5458	1945 -
Little Prickly Pear Creek ab Deadman Creek near Marysville, MT	97[2]	12N7W24B	1.2	not determined	not determined	not determined	1909 - 1912
Deadman Creek near Marysville, MT	98[2]	12N7W25	2.4	not determined	not determined	not determined	1909 - 1911
Lost Horse Creek near Marysville, MT	99[2]	12N7W25D	0	not determined	not determined	not determined	1909 - 1911
Little Prickly Pear Creek near Marysville, MT	100[2]	12N6W18C	2	not determined	2.7	25.9	1909 - 1933

STATION NAME	USGS STATION NO.	LOCATION[3]	MINIMUM STREAMFLOW (cfs) INSTANTANEOUS	DAILY	7-DAY, 10-YEAR LOW FLOW (cfs)	AVERAGE ANNUAL FLOW (cfs)	PERIOD OF RECORD
Marsh Creek near Marsyville, MT	101[2]	12N6W6	not determined	not determined	not determined	not determined	1909 - 1912
Canyon Creek near Canyon Creek, MT	102[2]	13N5W31B	5.6	not determined	not determined	not determined	1921 - 1923
Cottonwood Creek near Canyon Creek, MT	103[2]	13N5W31B	0.9	not determined	not determined	not determined	1921 - 1922
Little Prickly Pear Creek near Canyon Creek, MT	104[2]	12N5W9B	0	not determined	not determined	48.2	[1] 1909 - 1924
Little Prickly Pear Creek at Sieben Ranch near Wolf Creek, MT	06071100	13N4W8D	4.6	not determined	not determined	69.4	1962 - 1967
Little Prickly Pear Creek at Wolf Creek, MT	06071300	14N4W2AB	14	not determined	not determined	129	1962 - 1967
Missouri River at Cascade, Montana	110[2]	18N1W35AC	800	not determined	not determined	6360	1902 - 1915
Smith River near White Sulphur Springs, MT	111[2]	11N8E33	0	not determined	1.7	20.7	[1] 1922 - 1936
Smith River above Fivemile Creek near White Sulphur Springs, MT	113[2]	10N8E19A	not determined	not determined	not determined	not determined	1934 - 1943
Dearborn River above Falls Creek near Clemons, MT	106[2]	18N7W33A	13.7	not determined	not determined	not determined	1908 - 1912

STATION NAME	USGS STATION NO.	LOCATION[3]	MINIMUM STREAMFLOW (cfs) INSTANTANEOUS	DAILY	7-DAY, 10-YEAR LOW FLOW (cfs)	AVERAGE ANNUAL FLOW (cfs)	PERIOD OF RECORD
Falls Creek near Clemons, MT	107[2]	18N7W27	not determined	not determined	not determined	not determined	1908 - 1911
Dearborn River near Clemons, MT	06073000	18N7W23AA	7.4	not determined	9.2	116	[1] 1921 - 1953
Dearborn River near Craig, MT	06073500	17N4W27DAB	8	not determined	17.0	218	1945 - 1969
Missouri River at Craig, MT	105[2]	15N3W10A	1742	not determined	not determined	not determined	1890 - 1892
Missouri River near Ulm, MT	06078200	19N3E5BBA	not determined	1700	not determined	6644	1957 -
Sheep Creek near White Sulphur Springs, MT	06077000	12N7E26DCC	3.5	not determined	4.7	31.9	1941 - 1972
Newland Creek near White Sulphur Springs, MT	06076000	11N7E09	0.1	not determined	not determined	2.87	1945 - 1953
Newland Creek near Damsite near White Sulphur Springs, MT	0607650	10N6E14B	0	0.6	not determined	9.53	1950 - 1957
Smith River near Eden, MT	06077500	17N3E29CC	not determined	3.1	not determined	338	1951 - 1969
Smith River at Truly, MT	116[2]	19N2E35	0.2	not determined	not determined	not determined	[1] 1905 - 1932
N. Fork of N.Fork of Sun River near Augusta, MT	117[2]	22N10W26BB	27	not determined	not determined	348	[1] 1911 - 1950

STATION NAME	USGS STATION NO.	LOCATION[3]	MINIMUM STREAMFLOW (cfs) INSTANTANEOUS	MINIMUM STREAMFLOW (cfs) DAILY	7-DAY, 10-YEAR LOW FLOW (cfs)	AVERAGE ANNUAL FLOW (cfs)	PERIOD OF RECORD
So. Fork of N. Fork of Sun River near Augusta, MT	118[2]	22N10W27D	not determined	not determined	not determined	not determined	[1] 1911 - 1950
No. Fork Sun River near Augusta, MT	06078500	22N10W23CC	27	not determined	not determined	35	1911 - 1968
Willow Creek near Augusta, MT	123[2]	21N7W26CB	0	not determined	not determined	27.7	1905 - 1925
Smith Creek near Augusta, MT	125[2]	19N8WDB	6	not determined	not determined	37.6	1906 - 1913
Ford Creek near Augusta, MT	126[2]	20N8W31	0	not determined	not determined	not determined	1906 - 1912
Smith Creek below Ford Creek near Augusta, MT	0608400	20N7W32	-	12	not determined	65.7	1945 - 1952
Sun River below Div. Dam near Augusta, MT	06080900	22N9W36	0.2	41	not determined	448	1967 -
Sun River below Willow Creek near Augusta, MT	06082200	21N6W27BCA	0.2	34	not determined	469	1967 -
So. Fork Sun Rv. at Augusta, MT	128[2]	20N6W17DB	0	not determined	not determined	99.4	1904 - 1924
Sun River at Simms, MT	06085800	20N3W12DBB	not determined	37	not determined	572	1966 -
Sun River at Ft. Shaw, MT	131[2]	20N2W1C	38	not determined	not determined	939	1915 - 1928
Sun River at Sun River, MT	134[2]	21N1W34AB	37	not determined	not determined	1130	1905 - 1912

STATION NAME	USGS STATION NO.	LOCATION[3]	MINIMUM STREAMFLOW (cfs) INSTANTANEOUS	DAILY	7-DAY, 10-YEAR LOW FLOW (cfs)	AVERAGE ANNUAL FLOW (cfs)	PERIOD OF RECORD
Sun River near Vaughn, MT	06089000	21N2E33CAB	20	-	not determined	738	1934 -
Muddy Creek near Power, MT	135[2]	23N1W27CD	0.2	not determined	not determined	not determined	1935 - 1939
Muddy Creek near Vaughn, MT	06088300	22N1E32AB	15	15	not determined	-	1968 -
Muddy Creek at Vaughn, MT	06088500	21N1E24A	2.0	-	not determined	123	[1]1925 -
Belt Creek near Belt, MT	138[2]	20N7E18AB	0	not determined	not determined	not determined	1905 - 1906
Highwood Creek near Highwood, MT	139[2]	20N8E7A	0	not determined	not determined	not determined	1905 - 1906
Missouri River at Ft. Benton, MT	06090800	24N8E23DD	320	627	not determined	7700	1890 -

(1) Interrupted period of records.
(2) USGS Water Supply Paper 1309, 1959.
(3) See Appendix C, System for Geographic Location of Features.

TABLE 18. TYPICAL STREAM FLOW DATA FOR MISSOURI-SUN-SMITH BASIN (USGS WATER RESOURCES DATA, 1972)

MONTHLY MEAN DISCHARGE (cfs) FOR WATER YEAR OCTOBER 1971 to SEPTEMBER 1972

Station	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total for Year Acre-Feet	Total for Average Year Acre-Feet
Crow Creek near Radersburg	15.8	12.8	8.44	9.25	9.72	19.8	22.6	139	161	Station Discontinued(1)			NA(3)	34,560
Tenmile Creek near Rimini	0.58	0.55	0.47	0.52	0.54	5.44	7.52	74.1	52.5	1.75	1.20	0.50	8,830	12,750
Muddy Creek near Vaughn	113	53.8	29.9	24.6	33.8	44.0	28.7	158	299	398	447	270	NA	NA
Sun River at Simms	519	169	138	160	217	364	608	1279	3522	339	383	422	490,900	414,400
Missouri River at Toston	5659	5704	4031	4092	4542	5384	6686	9340	16,080	4815	3070	4022	4,432,000	3,847,000
Smith River(2) near Eden	357	315	260	211	164	219	157	906	550	568	189	137	304,400	244,900
Dearborn River(2) near Craig	81.6	57.5	46.6	63.2	42.5	131	519	468	401	332	72.9	41.1	136,400	157,900
Missouri River near Wolf Creek	5585	5326	5605	6206	6376	5658	7503	9137	9213	5626	5229	5799	5,137000	3,954,300

(1) Station discontinued on June 30, 1972.
(2) This station was discontinued September 30, 1969. Data given is for the water year October, 1968 to September, 1969.
(3) NA - not applicable.

River Reservoir would affect mainstem stream flows. About 24,500 acres are irrigated above the station (USGS Water Resources Data, 1969). Spring runoff from the substantial valley and foothill region can be expected to precede runoff from mountain portions of the drainage. Drainage area of the South Fork of the Smith River is almost entirely valley and foothills. No significant storage reservoirs are located in the Dearborn River drainage. However, flows are regulated by irrigation diversions above the discontinued USGS station near Craig. Dearborn Canal above Bean Lake is the major diversion. An estimated 2,500 acres in the Flat Creek drainage are irrigated by this diversion. Total irrigated land above the gaging station is estimated to be 3,300 acres. Flows in the Missouri River from Canyon Ferry downstream are regulated extensively by Canyon Ferry, Hauser and Holter Reservoirs. Reservoirs between Holter and Fort Peck Reservoirs are essentially run-of-river.

VIII. WATER QUALITY

Water quality has been regularly measured at 57 stations in the Missouri-Sun-Smith basin, Montana (Table 19). Temperature only was recorded at 23 of these 57 stations. Generally, water quality in the basin is excellent; however, several significant problems exist. Agricultural activity near Toston appears to be a significant source of nitrate to the Missouri River. Severe erosion of the Muddy Creek channel, approximately 15 miles northwest of Great Falls, is due largely to poor irrigation practices. Acid mine drainage in the Prickly Pear and Belt Creek drainages (Plate I) is degrading the indigenous aquatic community. Discharge of poorly treated sewage from the Great Falls municipal treatment plant is the apparent cause of high fecal coliform counts noted at Fort Benton.

Several independent studies of problem areas in the basin have been or are being conducted (Section III). Eutrophic conditions in Canyon Ferry Reservoir have been the subject of numerous investigations beginning in 1957 (Wright, 1958, 1959, 1960, 1961, 1965; Kaiser, 1971; Wright, Rada and Martin, 1974). Available data indicate Canyon Ferry Reservoir has become less eutrophic since 1957; however, there appears to be significant nitrogen input to the Missouri River immediately upstream of the reservoir. Runoff and drainage from agricultural lands between Toston and Townsend, Montana, is the apparent cause (Wright, Rada and Martin, 1974). Acid mine seeps from inactive coal mines south of Great Falls have seriously degraded the Sand Coulee Creek drainage (McArthur, 1971). Severe erosion of the Muddy Creek channel and resultant high sediment yields are due to large increases in natural flow from irrigation water wastage (Zollman, 1971; Bureau of Reclamation, 1967, 1971 and 1974). Scope of the Muddy Creek investigation was expanded greatly by the Bureau of Reclamation in 1973. Status of the investigation is uncertain; however, additional funding has been requested (Aycock, May 7, 1974). The Barker Mining District (Section VI), about 45 miles southeast of Great Falls, is the site of an on-going EPA sponsored study of acid mine drainage in the area. Seepage from inactive mines near Hughesville has degraded water quality in the Dry Fork of Belt Creek.

The Missouri-Sun-Smith basin has been divided into nine segments for purposes of this discussion. Typical water quality data for streams discussed in this report appear in

TABLE 19. MISSOURI-SUN-SMITH WATER QUALITY STATIONS

STATION NAME (AGENCY AND NO.)	LOCATION[1]	PERIOD OF RECORD	SAMPLING INTERVALS	WATER QUALITY PARAMETERS
Missouri River at Toston, MT (USGS 06054500)	5N2E36BD	1972-	Monthly	Dissolved: Ca, Mg, Na, SO_4, Cl, F, Solids, NO_2 + NO_3, Ortho Phosphorous, Phosphorous. Total P, Total N, Total Kjeldahl N, BOD, Specific conductance, Temperature, D.O., pH, Alkalinity, Flow
Missouri River below Canyon Ferry Dam (USGS 06058502)	10N1W4DDB	1967-	Daily Composite	Dissolved: SiO_2, Fe, Ca, Mg, Na, K, SO_4, Cl, F, NO_2 + NO_3, Ortho Phosphorous, Solids, Phosphorous, B, Mn, HCO_3, CO_3, Specific conductance, pH, Flow, Temperature
Missouri River near Great Falls, MT (USGS)	20N4E5B	1950-1951	Monthly	Flow, SiO_2, Fe, Ca, Mg, Na, K, HCO_3, SO_4, Cl, F, NO_3, B, Specific conductance, pH, Phenolic material as C_6H_5OH.
Missouri River at Highway 10N Bridge at Toston, MT (USGS)	5N2E23C	1949-1952 1951-1952	Daily Monthly	Flow, Suspended sediment, Temperature Flow, SiO_2, Fe, Ca, Mg, Na, K, HCO_3, SO_4, Cl, F, NO_3, B, Specific conductance, pH, Turbidity, NH_3-N, NO_2, NO_3, Organic-N, Total-N, Soluble-P, Total P
Sun River near Augusta, MT (USGS 06080000)	22N9W36BDB	1971-1972	Continuous	Temperature
Sun River below Diversion Dam near Augusta, MT (USGS 06080900)	22N9W36	1967-	Daily Composite	Dissolved: SiO_2, Fe, Ca, Mg, Na, K, SO_4, Cl, F, NO_2 + NO_3, Ortho Phosphorous, Solids. HCO_3, CO_3, Specific conductance, pH, Flow, Temperature
Sun River above Muddy Creek near Vaughn, MT (USGS 06087850)	21N1E25ADB	1971-1972	Continuous	Temperature
Muddy Creek near Vaughn, MT (USGS 06088300)	22N1E32AB	1968-	Daily Composite	Dissolved: SiO_2, Fe, Ca, Mg, Na, K, SO_4, Cl, F, NO_2 + NO_3, Ortho Phosphorous, Solids. HCO_3, CO_3, Specific conductance, pH, Flow, Temperature, Suspended sediment
Muddy Creek at Vaughn, MT (USGS 06088500)	22N1E24A	[2] 1967	Daily Composite	Dissolved: SiO_2, Fe, Ca, Mg, Na, K, SO_4, Cl, Fe, NO_2 + NO_3, Ortho Phosphorous, Solids. HCO_3, CO_3, Specific conductance, pH, Flow, Temperature, Suspended Sediment

STATION NAME (AGENCY AND NO.)	LOCATION (1)	PERIOD OF RECORD	SAMPLING INTERVALS	WATER QUALITY PARAMETERS
Sun River near Vaughn, MT (USGS 06089000)	21N2E33CBD	1968-	Daily Composite	Dissolved: SiO_2, Fe, Ca, Mg, Na, K, SO_4, Cl, F, NO_2 + NO_3, Ortho Phosphorous, Phosphorous, B, Mn. HCO_3, CO_3, Specific conductance, pH, Flow, Temperature
Missouri River at Ft. Benton, MT (USGS 06090800)	24N8E23DD	1969-	Monthly	Dissolved: Ca, Mg, Na, SO_4, Cl, F, Solids, NO_2 + NO_3, NH_3, Ortho Phosphorous, Phosphorous, O_2. Total Kjeldahl N, Total N, Total P, BOD, Alkalinity, Specific conductance, Temperature, Flow, Total and Fecal Coliforms
Little Prickly Pear Creek at Sieben Ranch near Wolf Creek, MT (USGS 06071100)	13N4W9D	1962-1967	Daily	Suspended Sediment, Temperature, Flow
Little Prickly Pear Creek at Sieben Ranch near Wolf Creek, MT (USGS 06071300)	14N4W2AB	1962-1967	Daily	Suspended Sediment, Temperature, Flow
Canyon Ferry Reservoir near Helena, MT (F & G) (3)	10N1W4DD	April through August, 1957 and 1958	Weekly	Temperature
Prickly Pear Creek near Clancy, MT (F & G)	9N3W23CA	1949-1953 1954-1965	Monthly	Temperature
Tenmile Creek near Rimini, MT (F & G)	9N5W20AC	1949-1965	Monthly	Temperature
Tenmile Creek near Helena, MT (F & G)	10N4W22C	1949-1954	Monthly	Temperature

STATION NAME (AGENCY AND NO.)	LOCATION[1]	PERIOD OF RECORD	SAMPLING INTERVALS	WATER QUALITY PARAMETERS
Lyons Creek near Wolf Creek, MT (F & G)	14N4W29A	1960-1965	Monthly	Temperature
Dearborn River near Clemons, MT (F & G)	18N7W23DD	1949-1953	Monthly	Temperature
Dearborn River near Craig, MT (F & G)	17N4W27DA	1949-1965	Monthly	Temperature
Newland Creek near White Sulphur Springs, MT (F & G)	11N7E9	1949-1950 1959-1965	Monthly	Temperature
Newland Creek near Damsite near White Sulphur Springs, MT (F & G)	10N6E14B	1950-1957	Monthly	Temperature
Sheep Creek near White Sulphur Springs, MT (F & G)	12N7E26DC	1949-1965	Monthly	Temperature
Tenderfoot Creek near Neihart, MT (F & G)	14N6E36D	August-November, 1963	Daily	Temperature
Tenderfoot Creek Near Monarch, MT (F & G)	14N5E30B	July-Oct., 1962; Aug.-Sept., 1963	Daily	Temperature
Smith River near Eden, MT (F & G)	17N3E29CC	[2] 1951-1965	Monthly	Temperature
Missouri River above Sun River at Great Falls, MT (F & G)	20N3E14AB	1957-1965	Monthly	Temperature

STATION NAME (AGENCY AND NO.)	LOCATION[1]	PERIOD OF RECORD	SAMPLING INTERVALS	WATER QUALITY PARAMETERS
North Fork Sun River near Augusta, MT (F & G)	22N10W23CC	1949-1965	Monthly	Temperature
Muddy Creek at Vaughn, MT (F & G)	21N1E24A	1949-1965	Monthly	Temperature
Sun River near Vaughn, MT (F & G)	21N2E33CD	1949-1965	Monthly	Temperature
Missouri River at Ryan Dam near Black Eagle, MT (F & G)	21N5E17CD	[2] 1917-1928 1930-1964	Daily	Temperature
Belt Creek near Monarch, MT (F & G)	17N6E26BC	1951-1965	Monthly	Temperature
Belt Creek at Belt, MT (F & G)	19N6E26B	June-July, 1962	Daily	Temperature
Sixteenmile Creek at Lombard, MT (WQB)	6N7E23AAA	June, 1973-Present	Monthly (June-Oct.) Quarterly Oct.-April)	Ca, Mg, Na, SO_4, Cl, Alkalinity, NO_3, PO_4, F, Specific conductance, pH, Turbidity, Temperature, Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Sixteenmile Creek at Lombard, MT (WQB)	4N3E17B	June, 1973-Present	Monthly (June-Oct.)Quarterly Oct.-April)	Ca, Mg, Na, SO_4, Cl, Alkalinity, NO_3, PO_4, F, Specific conductance, pH, Turbidity, Temperature, Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Crow Creek near Radersburg, MT (WQB)	6N1W14DDA	June, 1973-Present	Monthly (June-Oct.) Quarterly Oct.-April)	Ca, Mg, Na, SO_4, Cl, Alkalinity, NO_3, PO_4, F, Specific Conductance, pH, Turbidity, Temperature, Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Crow Creek near Mouth near Toston, MT (WQB)	5N2E16DBC	June, 1973-Present	Monthly (June-Oct.) Quarterly Oct.-April)	Ca, Mg, Na, SO_4, Cl, Alkalinity, NO_3, PO_4, F, Specific conductance, pH, Turbidity, Temperature, Flow, BOD_5, D.O., Total Coliforms. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu

STATION NAME (AGENCY AND NO.)	LOCATION[1]	PERIOD OF RECORD	SAMPLING INTERVALS	WATER QUALITY PARAMETERS
Prickly Pear Creek near Clancy, MT (WQB)	9N3W23	June, 1973-Present	Monthly (June-Oct.) Quarterly (Oct.-April)	Ca, Mg, Na, SO_4, Cl, Alkalinity, NO_3, PO_4, F, Specific conductance, pH, Turbidity, Temperature, Flow, BOD_5, D.O., Total Coliforms, Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Prickly Pear Creek near Mountain View School near Helena, MT (WQB)	10N3W3BBA	June, 1973-Present	Monthly (June-Oct.) Quarterly Oct.-April	Ca, Mg, Na, SO_4, Cl, Alkalinity, NO_3, PO_4, Specific conductance, pH, Turbidity, Temperature, Flow, BOD_5, D.O., Total Coliforms. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Dearborn River near Clemons, MT (WQB)	5N2E16DBC	June, 1973-Present	Monthly (June-Oct.) Quarterly (Oct.-April)	Ca, Mg, Na, SO_4, Cl, Alkalinity, NO_3, PO_4, F, Specific conductance, pH, Turbidity, Temperature, Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Dearborn River near Craig, MT (WQB)	17N4W27DAB	June, 1973-Present	Monthly (June-Oct. Quarterly (Oct.-April)	Ca, Mg, Na, SO4, Cl, Alkalinity, NO_3, PO_4, F, Specific conductance, pH, Turbidity, Temperature, Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Sun River below Diversion Dam near Augusta, MT (WQB)	22N9W36DAA	June, 1973-Present	Monthly (June-Oct.) Quarterly (Oct.-April)	Turbidity, Total Coliforms, Temperature, Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Sun River at Simms, MT (WQB)	20N3W12DB	June, 1973-Present	Monthly (June-Oct.) Quarterly Oct.-April)	[4] Ca, Mg, Na, SO_4, Cl, Alkalinity, NO_3, PO_4, F, Specific conductance, pH, Turbidity, Temperature, flow.
Sun River near Vaughn, MT (WQB)	21N2E33CDA	June, 1973-Feb., 1974	Monthly (June-Oct.) Quarterly (Oct.-April)	Temperature, Flow, Total Coliforms. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
North Fork Smith River at White Sulphur Springs, MT (WQB)	9N6E12ABB	June, 1973-Feb., 1974	Monthly (June-Oct.) Quarterly (Oct.-April)	Ca, Mg, Na, SO4, Cl, Alkalinity, NO_3, PO_4, F, Specific conductance, pH, Turbidity, Temperature, Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Sun River at Ft. Shaw, MT (WQB)	20N2W2DDA	June, 1973-Present	Monthly (June-Oct.) Quarterly (Oct.-April)	[4] Ca, Mg, Na, SO4, CL, Alkalinity, NO_3, PO_4, F, Specific Conductance, pH, Turbidity, Temperature, Flow.

STATION NAME (AGENCY AND NO.)	LOCATION[1]	PERIOD OF RECORD	SAMPLING INTERVALS	WATER QUALITY PARAMETERS
South Fork Smith River near White Sulphur Springs, MT (WQB)	8N6E30CAB	June, 1973-Feb., 1974	Monthly (June-Oct.) Quarterly (Oct.-April)	Ca, Mg, Na, SO_4, Cl, Alkalinity, NO_3, PO_4, F, Specific conductance, pH, Turbidity, Temperature, Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Smith River near White Sulphur Springs, MT (WQB)	10N5E25CCC	July, 1973-Feb., 1974	Monthly (June-Oct.) Quarterly (Oct.-April)	Ca, Mg, Na, SO_4, Cl, Alkalinity, NO_3, PO_4, F, Specific conductance, pH, Turbidity, Temperature, Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Smith River near Eden, MT (WQB)	17N3E29CCC	June, 1973-Feb., 1974	Monthly (June-Oct.)Quarterly (Oct.-April)	[4] Ca, Mg, Na, SO_4, Cl, Alkalinity, NO_3, PO_4, Specific conductance, Turbidity, Temperature, Flow, Total Coliforms, D.O., BOD_5. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Muddy Creek near Power, MT (WQB)	23N1W27CDD	June, 1973-Feb., 1974	Monthly (June-Oct.) Quarterly (Oct.-April)	Specific conductance, Turbidity, Temperature, Flow.
Belt Creek near Neihart, MT (WQB)	13N8E3C	June, 1973-Feb., 1974	Monthly (June-Oct.) Quarterly (Oct.-April)	Ca, Mg, Na, SO_4, Cl, Alkalinity, NO_3, PO_4, F, Specific conductance, pH, Turbidity, Temperature, Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Belt Creek above Dry Fork near Monarch, MT (WQB)	15N7E4AAA	Aug. 21 and Sept. 8, 1973	Twice on dates specified	Ca, Mg, Na, SO4, Cl, Alkalinity, NO3, PO4, F, Specific conductance, pH, Turbidity, Temperature, Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Belt Creek at Riceville, MT (WQB)	17N6E26BDB	June, 1973-Present	Monthly (June-Oct.) Quarterly (Oct.-April)	Ca, Mg, Na, SO_4, Cl, Alkalinity, NO_3, PO_4, F, Specific conductance, pH, Turbidity, Temperature, Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Belt Creek near Mouth (WQB)	21N5E12DDB	June, 1973-Present	Monthly (June-Oct.) Quarterly (Oct.-April)	Ca, Mg, Na, SO_4, Cl, Alkalinity, NO_3, PO_4, F, Specific conductance, pH, Turbidity, Temperature, Flow, Total Coliforms, BOD_5. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Missouri River at Toston, MT (WQB)	5N2E36BDD	June, 1973-Present	Quarterly	Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu

STATION NAME (AGENCY AND NO.)	LOCATION[1]	PERIOD OF RECORD	SAMPLING FREQUENCY	WATER QUALITY PARAMETERS
Missouri River at Townsend, MT (WQB)	7N2E30BCA	Aug. 1972-May, 1973	Monthly	Ca, Mg, Na, SO_4, Cl, Alkalinity, NO_3, PO_4, F, Specific conductance, pH, Turbidity, Temperature, Flow, Total Coliforms, D.O., BOD_5. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Missouri River below Canyon Ferry Reservoir (WQB)	10N1W4DDB	June, 1973-Feb., 1974	Quarterly	Turbidity, Total Coliforms, Temperature, Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Missouri River below Hauser Dam (WQB)	12N2W29CDB	June, 1973-Feb., 1974	Monthly (June-Oct.) Quarterly (Oct.-April)	Ca, Mg, Na, SO_4, Cl, F, Alkalinity, NO_3, PO_4, Specific conductance, pH, Turbidity, Temperature, Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Missouri River below Holter Dam (WQB)	14N3W5DCB	June, 1973-Feb., 1974	Monthly (June-Oct.) Quarterly (Oct.-April)	Ca, Mg, Na, SO_4, Cl, F, Alkalinity, NO_3, PO_4, Specific conductance, pH, Turbidity, Temperature, Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Missouri River below Morony Dam (WQB)	21N5E11CDB	June, 1973-Feb., 1974	Monthly (June-Oct.) Quarterly (Oct.-April)	[4] Ca, Mg, Na, SO_4, Cl, F, Alkalinity, NO_3, PO_4, Specific Conductance, pH, Turbidity, Total Coliforms, BOD_5, D.O., Temperature, Flow. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Missouri River at Ft. Benton, MT (WQB)	24N8E26ABC	June, 1973-Present	Quarterly	Turbidity, Specific conductance, Temperature, Flow, Total Coliforms, BOD_5. Total Recoverable: As, Fe, Zn, Cd, Pb, Cu
Newland Creek below Sheep Creek Diversion (SCS)	10N6E12DCB	May, 1973-Present	Quarterly	Ca, Mg, Na, Alkalinity, SO_4, Cl, pH, Specific conductance, Temperature, Turbidity, Flow
Newland Creek above Sheep Creek Diversion (SCS)	11N7E10DB	May, 1973-Present	Quarterly	Ca, Mg, Na, Alkalinity, SO_4, Cl, pH, Specific conductance, Temperature, Turbidity, Flow
Sheep Creek Diversion at Newland Creek (SCS)	11N7E9DBB	May, 1973-Present	Quarterly	Ca, Mg, Na, Alkalinity, SO_4, Cl, pH, Specific Conductance, Temperature, Turbidity, Flow

STATION NAME (AGENCY AND NO.)	LOCATION(1)	PERIOD OF RECORD	SAMPLING FREQUENCY	WATER QUALITY PARAMETERS
Sheep Creek Diversion At Sheep Creek (SCS)	12N7E26CDC	May, 1973-Present	Quarterly	Ca, Mg, Na, Alkalinity, SO_4, Cl, pH, Specific conductance, Temperature, Turbidity, Flow
Big Coulee Creek near Simms, MT (WQB)	20N2W5	June, 1973-Present	Quarterly	Specific conductance, Turbidity, Temperature, Flow, PO_4, NO_3
Mill Coulee Creek near Sun River, MT (WQB)	21N1W27	June, 1973-Present	Quarterly	Specific conductance, Turbidity, Temperature, Flow, PO_4, NO_3
Muddy Creek near Power, MT (BR)	23N1W27	Oct., 1972-Present	Quarterly	Specific conductance, Turbidity, Flow, Suspended sediment
Muddy Creek downstream of Spring Coulee (BR)	22N1W24	Oct., 1972-Present	Quarterly	Specific conductance, Turbidity, Flow Suspended sediment
Drain AA (BR)	22N2W4	May, 1973-Present	Quarterly	Specific conductance, Turbidity, Flow
Drain A (BR)	23N1W30	May, 1973-Present	Quarterly	Specific conductance, Turbidity, Flow
Muddy Creek upstream of Spring Coulee (BR)	22N1W24	Oct., 1972-Present	Quarterly	Specific conductance, Turbidity, Flow
Spring Coulee (J Wasteway) (BR)	22N1W14	Oct., 1972-Present	Quarterly	Specific conductance, Turbidity, Flow
Drain F (Greenfields Main) (BR)	22N1W22	Oct., 1972-Present	Quarterly	Specific conductance, Turbidity, Flow
Drain G (BR)	22N1W24	Oct., 1972-Present	Quarterly	Specific conductance, Turbidity, Flow
Muddy Creek near Vaughn, MT (BR)	22N1E32	Oct., 1972-Present	Quarterly	Specific conductance, Turbidity, Flow

STATION NAME (AGENCY AND NO.)	LOCATION[1]	PERIOD OF RECORD	SAMPLING FREQUENCY	WATER QUALITY PARAMETERS
Canal AB (BR)	22N2W3A	May, 1973-Present	Quarterly	Specific conductance, Turbidity, Flow
Muddy Creek near Pump Station (BR)	22N2W3A	Oct., 1972-Present	Quarterly	Specific conductance, Turbidity, Flow
Drain C (BR)	22N1W3D	Oct., 1972-Present	Biweekly during irrigation season. Quarterly in winter.	Specific conductance, Turbidity, Flow
Drain D (BR)	22N1W11C	Oct., 1972-Present	Biweekly during irrigation season. Quarterly in winter.	Specific conductance, Turbidity, Flow
Drain I (BR)	30N1E30A	May, 1973-Present	Biweekly during irrigation season. Quarterly in winter.	Specific conductance, Turbidity, Flow
Sun River upstream of Muddy Creek (BR)	21N1E25D	Oct., 1973-Present	Biweekly during irrigation season. Quarterly in winter.	Specific conductance, Turbidity, Flow
Sun River downstream of Muddy Creek (BR)	21N1E30B	Oct., 1973-Present	Biweekly during irrigation season. Quarterly in winter.	Specific conductance, Turbidity, Flow
Sun River near Vaughn, MT (BR)	21N2E33CD	Oct., 1973-Present	Biweekly during irrigation season. Quarterly in winter.	Specific conductance, Turbidity, Flow

STATION NAME (AGENCY AND NO.)	LOCATION(1)	PERIOD OF RECORD	SAMPLING FREQUENCY	WATER QUALITY PARAMETERS
Mill Coulee at Intersection of Hwys. 218 and 289 (BR)	21N1W26C	April, 1973-Present	Biweekly during irrigation season. Quarterly in winter.	Specific conductance, Turbidity, Flow
Muddy Creek at Vaughn, MT (BR)	21N1E24	Oct. 1972-Present	Biweekly during irrigation season. Quarterly in winter.	Specific conductance, Turbidity, Flow
Muddy Creek at Cliev, MT (BR)	22N2W5	Oct. 1972-Present	Biweekly during irrigation season. Quarterly in winter.	Specific conductance, Turbidity, Flow, Suspended sediment
Muddy Creek at Cordova, MT (BR)	23N1W30	Oct. 1972-Present	Biweekly during irrigation season. Quarterly in winter.	Specific conductance, Turbidity, Flow, Suspended sediment

(1) See Appendix C.
(2) Interrupted period of record.
(3) Data published by Montana Department of Fish and Game.
(4) Analyses indicated may not be complete for each sampling interval.

Table 20. Dissolved oxygen determinations have been minimal. Dissolved oxygen is seldom a water quality limiting parameter in the Missouri-Sun-Smith basin. Stream temperatures typically vary from 0° C in winter to the high-teens and mid-twenties for small mountain streams and large rivers, respectively. All samples collected by the Water Quality Bureau (Table 20) were grab samples and were analyzed in the Department of Health and Environmental Sciences Chemistry Laboratory.

TABLE 20. MISSOURI-SUN-SMITH BASIN WATER QUALITY SUMMARY[1]

Flow - cubic feet per second
Temperature - °C
Turbidity - Jackson Turbidity Units
Specific Conductance - μ℧/cm at 25° C
pH - S.U.
Calcium - Ca
Magnesium - Mg
Sodium - Na
Potassium - K

Bicarbonate - HCO_3
Carbonate - CO_3
Sulfate - SO_4
Chloride - Cl
Fluoride - Fl
Nitrate - NO_3
Ortho Phosphate - PO_4
BOD_5 - mg/l
Total Coliforms/100 ml

Fecal Coliforms/100 ml
[2] TR Cadmium - Cd
TR Zinc - Zn
TR Arsenic - As
TR Iron - Fe
TR Copper - Cu
TR Lead - Pb
Dissolved Oxygen - mg/l
Suspended Sediment - tpd

SAMPLING STATION DESIGNATION	SAMPLING LOCATION	DATE SAMPLED	WATER QUALITY PARAMETERS					
Missouri River at Toston, MT	5N2E36BD	6/7/73	Flow	580	HCO_3	116	F. Coliform	-
			Temp.	11.0	CO_3	7	Cd	0.01
			Turbidity	-	SO_4	29	Zn	0.01
			S. Conductance	270	Cl	6	As	0.01
			pH	8.5	Fl	0.65	Fe	0.52
			Ca	31	NO_3	0.27	Cu	0.01
			Mg	9	PO_4	0.08	Pb	0.01
			Na	14	BOD_5	<1.0	DO	10.0
			K	-	T. Coliform	100	TSS	-
Missouri River below Canyon Ferry Dam	10N1W4DDB		Flow	5560	HCO_3	163	F. Coliform	-
			Temp.	-	CO_3	4	Cd	<0.01
			Turbidity	2.0	SO_4	39	Zn	0.01
			S. Conductance	375	Cl	10.5	As	0.02
			pH	8.5	Fl	1.2	Fe	0.06
			Ca	40	NO_3	0.25	Cu	0.01
			Mg	12	PO_4	0.20	Pb	<0.01
			Na	23	BOD_5	-	DO	9.6
			K	-	T. Coliform	65	TSS	-

(1) Concentrations are in milligrams per liter unless otherwise indicated.
(2) TR - Total Recoverable (5 ml concentrated nitric acid added to 1,000 ml of unfiltered sample).

SAMPLING STATION DESIGNATION	SAMPLING LOCATION	DATE SAMPLED	WATER QUALITY PARAMETERS					
Sun River below diversion dam near Augusta, MT	22N9W36	9/1/72-9/30/72	Flow	299	HCO_3	146	F. Coliform	-
			Temp.	-	CO_3	0	Cd	-
			Turbidity	-	SO_4	22	Zn	-
			S. Conductance	264	Cl	0.9	As	-
			pH	7.8	Fl	0.1	Fe	-
			Ca	40	NO_3	0.00	Cu	-
			Mg	9.8	PO_4	0.00	Pb	-
			Na	1.5	BOD_5	-	DO	-
			K	0.8	T. Coliform	-	TSS	-
Muddy Creek near Vaughn, MT	22N1E32AB	8/1/72-8/30/72	Flow	369	HCO_3	256	F. Coliform	-
			Temp.	-	CO_3	0	Cd	-
			Turbidity	-	SO_4	87	Zn	-
			S. Conductance	548	Cl	2.9	As	-
			pH	7.9	Fl	0.6	Fe	-
			Ca	44	NO_3	0.26	Cu	-
			Mg	33	PO_4	0.00	Pb	-
			Na	27	BOD_5	-	DO	-
			K	1.5	T. Coliform	-	TSS	12,882
Sun River near Vaughn, MT	21N2E33CDB	8/11/72-8/31/72	Flow	1010	HCO_3	243	F. Coliform	-
			Temp.	-	CO_3	0	Cd	-
			Turbidity	-	SO_4	120	Zn	-
			S. Conductance	586	Cl	2.4	As	-
			pH	8.0	Fl	0.5	Fe	-
			Ca	53	NO_3	0.13	Cu	-
			Mg	30	PO_4	0.00	Pb	-
			Na	27	BOD_5	-	DO	-
			K	1.9	T. Coliform	-	TSS	-
Missouri River at Fort Benton, MT	24N8E23DD	8/15/72	Flow	10,400	HCO_3	116	F. Coliform	460
			Temp.	21.0	CO_3	-	Cd	-
			Turbidity	-	SO_4	61	Zn	-
			S. Conductance	380	Cl	7.2	As	-
			pH	8.4	Fl	1.0	Fe	-
			Ca	41	NO_3	-	Cu	-
			Mg	14	PO_4	-	Pb	-
			Na	17	BOD_5	1.8	DO	8.0
			K	-	T. Coliform	2700	TSS	-

SAMPLING STATION DESIGNATION	SAMPLING LOCATION	DATE SAMPLED	WATER QUALITY PARAMETERS					
Sixteenmile Creek at Lombard, MT	4N3E17B	10/4/73	Flow	35	HCO_3	205	F. Coliform	-
			Temp.	5.0	CO_3	6	Cd	<0.01
			Turbidity	<0.9	SO_4	112	Zn	<0.01
			S. Conductance	575	Cl	3.5	As	<0.01
			pH	8.5	Fl	0.45	Fe	0.07
			Ca	69	NO_3	0.01	Cu	<0.01
			Mg	23	PO_4	0.04	Pb	<0.01
			Na	12	BOD_5	-	DO	-
			K	-	T. Coliform	-	TSS	
Crow Creek near mouth near Toston, MT	5N2E16DBC	10/4/73	Flow	19.2	HCO_3	229	F. Coliform	-
			Temp.	7.0	CO_3	5	Cd	<0.01
			Turbidity	28.0	SO_4	182	Zn	0.05
			S. Conductance	832	Cl	0	As	<0.01
			pH	8.4	Fl	0.63	Fe	0.12
			Ca	80	NO_3	3.9	Cu	<0.01
			Mg	31	PO_4	0.16	Pb	<0.01
			Na	50	BOD_5	-	DO	-
			K	-	T. Coliform	-	TSS	-
Prickly Pear Creek near Clancy, MT	9N3W23	8/1/73	Flow	9.5	HCO_3	84	F. Coliform	-
			Temp.	23.4	CO_3	9	Cd	<0.01
			Turbidity	1.0	SO_4	51	Zn	0.06
			S. Conductance	278	Cl	1.5	As	<0.01
			pH	8.8	Fl	0.06	Fe	0.18
			Ca	29	NO_3	0.11	Cu	0.01
			Mg	6.8	PO_4	0.09	Pb	0.03
			Na	18	BOD_5	-	DO	7.9
			K	-	T. Coliform	30	TSS	-
Prickly Pear Creek near Mountain View School near Helena, MT	10N3W3BBA	9/19/73	Flow	20.4	HCO_3	249	F. Coliform	-
			Temp.	13.0	CO_3	-	Cd	<0.01
			Turbidity	2.0	SO_4	90	Zn	0.03
			S. Conductance	661	Cl	25	As	<0.01
			pH	7.6	Fl	0.82	Fe	0.26
			Ca	68	NO_3	1.8	Cu	0.01
			Mg	19.9	PO_4	3.4	Pb	0.01
			Na	37	BOD_5	3.7	DO	3.8
			K	-	T. Coliforms	9700	TSS	-

SAMPLING STATION DESIGNATION	SAMPLING LOCATION	DATE SAMPLED	WATER QUALITY PARAMETERS					
Dearborn River near Craig, MT	17N4W27DAB	7/18/73	Flow	8.0	HCO_3	188	F. Coliform	-
			Temp.	19.0	CO_3	2	Cd	<0.01
			Turbidity	<0.9	SO_4	15.6	Zn	0.02
			S. Conductance	-	Cl	0.2	As	<0.01
			pH	8.4	Fl	0.14	Fe	<0.01
			Ca	45	NO3	0.39	Cu	<0.01
			Mg	13.0	PO_4	<0.01	Pb	0.01
			Na	2.8	BOD_5	-	DO	-
			K	-	T. Coliform	-	TSS	-
Smith River near White Sulphur Springs, MT	10N5E25CCC	10/4/73	Flow	30	HCO_3	264	F. Coliform	-
			Temp.	3.0	CO_3	0	Cd	<0.01
			Turbidity	<0.9	SO_4	38	Zn	0.02
			S. Conductance	-	Cl	8.9	As	<0.01
			pH	8.3	Fl	0.39	Fe	0.08
			Ca	62	NO3	0.09	Cu	<0.01
			Mg	17.5	PO_4	0.02	Pb	<0.01
			Na	19	BOD_5	-	DO	-
			K	-	T. Coliform	-	TSS	-
Smith River near Eden, MT	17N3E29CCC	10/18/73	Flow	5000	HCO_3	192	F. Coliform	-
			Temp.	10.0	CO_3	0	Cd	<0.01
			Turbidity	3.0	SO_4	68	Zn	0.03
			S. Conductance	443	Cl	9.0	As	<0.01
			pH	7.7	Fl	0.30	Fe	0.22
			Ca	48	NO3	0.46	Cu	<0.01
			Mg	15.8	PO_4	0.27	Pb	<0.01
			Na	22	BOD_5	-	DO	9.7
			K	-	T. Coliform	>800	TSS	-
Belt Creek near Mouth	21N5E12DDB	9/12/73	Flow	0.1	HCO_3	151	F. Coliform	-
			Temp.	20.0	CO_3	4	Cd	<0.01
			Turbidity	0.9	SO_4	162	Zn	0.05
			S. Conductance	604	Cl	3.7	As	<0.01
			pH	8.6	Fl	0.23	Fe	0.03
			Ca	50	NO3	0.25	Cu	<0.01
			Mg	19.6	PO_4	0.06	Pb	<0.01
			Na	46	BOD_5	<0.03	DO	-
			K	-	T. Coliform	-	TSS	-

SAMPLING STATION DESIGNATION	SAMPLING LOCATION	DATED SAMPLED	WATER QUALITY PARAMETERS	
Sun River near Vaughn, MT	21N2E33CD	July, 1973 Arithmetic Mean	Turbidity	70
			S. Conductance . .	850(3)

(3) August 24, 1973 only.

SIXTEENMILE CREEK

Sixteenmile Creek begins on the northeast slopes of the Crazy Mountains, flows for about 20 miles out along a flat divide between the Shields and Smith River valleys and then enters an isolated 20-mile canyon region separating the Bridger and Big Belt Mountains. The creek joins the Missouri River at Lombard, Montana, about three miles after leaving the canyon section (Plate I). The upper (divide) region is grazing land and supports several ranches. Many small private irrigation reservoirs exist in this area to augment stream flows for irrigating adjacent hay lands. The lower (canyon) region encompasses about 50 percent of the drainage area, is very mountainous and has limited access. Logging and livestock grazing are the major activities. Irrigation is limited, and there are no storage reservoirs in this section.

Summertime flows at Ringling, Montana, (Plate I) are small, averaging about 1 cfs. Water passing the Ringling station (Table 20) is a hard, sodium bicarbonate type with some iron. Turbidities of 2 JTU or less are an indication that upstream agricultural activity is not significantly affecting water quality. However, poor irrigation practices along Hay, Faulkner and Battle Creeks reportedly result in high sediment loads to Sixteenmile Creek downstream of Ringling (Helena National Forest, 1973). This condition probably is transient as it could not be confirmed by aerial surveillance on June 10, 1974. Summertime flows at Lombard (Plate I) average about 30 cfs. Significant input of high quality, calcium bicarbonate water from the Madison Formation occurs in the canyon region, resulting in the higher flows and a calcium bicarbonate type water at Lombard.

CROW CREEK

Crow Creek rises in the Elkhorn Mountains and flows in an easterly direction to the Missouri River at Toston, Montana, 45 miles southeast of Helena (Plate I). Crow Creek upstream of the USGS station near Radersburg (Table 20), is a pristine mountain stream little affected by logging, livestock grazing, recreation and mining activity occurring in its watershed. Water passing the USGS station is calcium bicarbonate with low turbidity and low sodium, chloride and sulfate concentrations.

Extensive agricultural development in the Crow Creek drainage between Radersburg, Montana, and the Missouri River has a major effect upon the stream flows and water quality of

Crow Creek. Crow Creek near the mouth is a moderately turbid, calcium bicarbonate, very hard water with significantly increased sodium, chloride and sulfate concentrations. Nitrate concentrations near the mouth were 258 mg/l, 0.28 mg/l, 3.2 mg/l and 3.9 mg/l for samples collected on April 6, 1973, July 27, 1973, September 5, 1973 and October 4, 1973, respectively. Ortho phosphate concentrations remained relatively unchanged at about 0.18 mg/l. Summertime flows near the mouth are erractic and varied from 34.2 cfs to 7.2 cfs to 19.2 cfs when samples were collected in July, September and October, 1973. Natural stream flows in lower Crow Creek are augmented by the Crow Creek Pumping Unit, which supplies irrigation water from the Missouri River.

PRICKLY PEAR CREEK

Prickly Pear Creek heads in the mountains south of Helena and flows north for about 14 miles before reaching the Prickly Pear or Helena valley at Montana City. It then continues north for 12 miles across the valley before being joined by Tenmile Creek. Prickly Pear Creek terminates at Lake Helena two miles downstream from the confluence with Tenmile Creek (Plate I). The stream has and continues to suffer many abuses. Placer mining, construction of highways and railroads, and industry have obiterated must of the original channel upstream of East Helena, Montana. The creek is also subjected to metal pollution from abandoned mines (Section VI), thermal discharges (Section VI), discharge of poorly treated sewage, and extensive dewatering for irrigation.

Prickly Pear Creek at the USGS station near Clancy (Table 19) is a moderately hard, calcium bicarbonate water with lesser amounts of sodium and sulfate. Moderate iron, zinc, lead and copper concentrations (Table 13) are attributed to drainage from inactive mines in the Corbin and Wickes area (Section VI). Total coliform density and nutrient concentrations determined were low.

Prickly Pear Creek near Mountain View School (Table 19), about eight miles north of Helena and approximately 0.3 mile below Helena's sewage treatment plant discharge, is seriously degraded by Helena's discharge of poorly treated sewage. Total coliform densities as high as 99 x 10^3 organisms/100 ml, nitrate concentrations up to 4.0 mg/l and ortho phosphate concentrations from 0.01 to 0.09 mg/l have been measured. Dissolved oxygen levels as low as 3.5 mg/l were recorded.

DEARBORN RIVER

The Dearborn River begins in a primitive mountain area on the east flank of the Continental Divide, southwest of Augusta, Montana (Plate I). Most of this area is unroaded and has experienced relatively little degradation by man. As a result, water quality is high (Table 20). After leaving the mountains, the Dearborn flows easterly, through broken grazing land, to the Missouri River about five miles below Craig, Montana. It is generally an isolated stream, crossed only occasionally by state, county and private roads.

Water quality of the Dearborn remains essentially unaltered between sampling stations near Clemons and near Craig (Table 19). At these points, the river is a calcium bicarbonate, moderately hard water with low sodium, sulfate and chloride. Toxic metals concentrations are far below those reported to affect salmonid fishes (McKee and Wolf, 1963). However, a significant input of sediment has been observed between the near Craig station and the river's mouth. Irrigation return flows from agricultural lands in the Flat Creek drainage are the suspected source. This has not been confirmed due to very limited access in the lower Dearborn. Aerial surveillance on July 9, 1974 indicated considerable disturbance of lands adjacent to the Dearborn River near its mouth. This land has been subdivided and is being developed for second homesites.

SUN RIVER

The Sun River originates on the east slope of the Continental Divide west of August, Montana (Plate I). Few roads penetrate this headwaters region, which includes part of the Bob Marshall Wilderness Area. East of the mountains, the Sun River and its tributaries are developed extensively for irrigation; thus, summertime flows are erratic below Gibson Dam. Concentrations of major chemical constituents increase with downstream distance. Changes in geology, tributaries and irrigation return flows are the causes. Turbidities were low, generally below 3 JTU for stations downstream to Fort Shaw. Heavy metal concentrations were low in this river reach and not considered significant to aquatic life. Between Fort Shaw and the USGS station near Vaughn, Montana, the Sun experiences a dramatic increase in suspended solids. Muddy Creek discharges a heavy sediment load to the Sun River at Vaughn.

MUDDY CREEK

Soil erosion is the major problem in the Muddy Creek drainage (Tables 20 and 21). Approximately 200,000 tons of soil per year are eroded and transported to the Sun River (Bureau of Reclamation, 1973). Unstable soils and abnormally high flows caused by excess irrigation water being returned to Muddy Creek are major factors. The lowest reach of Muddy Creek from the USGS station near Vaughn (Table 19) to the Sun River, is in serious condition with a degrading, meandering channel and five to 15-foot high vertical banks (Bureau of Reclamation, 1970). Muddy Creek above Power (24 miles northwest of Great Falls) has some sections of erosion but generally is stable. Between Power and the USGS station near Vaughn (Table 19), the channel has a hard sandy-shale bottom and is quite stable. An extensive study of the creek and irrigation waste flows to it was initiated by the Bureau of Reclamation in 1973 (Section III).

Moderate nitrate levels also are present in Muddy Creek. Concentrations measured at Power varied from 0 mg/l to 8.8 mg/l NO_3^-. Similar nitrate levels were measured by the USGS at their sampling stations near Vaughn and at Vaughn (USGS Water Quality Records, 1968, 1969, 1970).

TABLE 21. TURBIDITY MEASUREMENTS OF MUDDY CREEK

Station	Date	Flow - cfs	Turbidity - JTU
Power(1)	7/18/73	51.5	120
	8/30/73	43.0	23
	9/18/73	21.7	5.0
	9/27/73	26.0	19
	10/25/73	16.0	8.2
Near Vaughn(2)	4/73	-	38
	5/73	92	56
	6/73	255	135
	7/73	242	87
	8/73	196	61
	9/73	88	5
	10/73	56	9

(1) Water Quality Bureau sampling.
(2) Bureau of Reclamation, January 24, 1974, arithmetic mean for month.

Station	Date	Flow - cfs	Turbidity - JTU
At Vaughn(2)	4/73	-	147
	5/73	-	96
	6/73	-	210
	7/73	-	171
	8/73	-	79
	9/73	-	25
	10/73	-	19

(2) Bureau of Reclamation, January 24, 1974, arithmetic mean for month.

SMITH RIVER

The Smith River is formed by the confluence of its north and south forks four miles southwest of White Sulphur Springs (Plate I). After flowing northwest for about 25 miles, the river enters a narrow mountain canyon ten miles north of Fort Logan. Upon leaving the canyon, the river meanders through a relatively narrow agricultural valley flanked by rolling grasslands. It joins the Missouri River at Ulm about ten miles southeast of Great Falls. Numerous high quality tributaries join the river all along its length. Farming, ranching, and logging are the predominant activities in the drainage.

The Smith River to the mouth of the canyon is an excellent quality, moderately hard, calcium bicarbonate stream, except high temperatures have been noted at the inactive USGS station near Eden (Table 22). Turbidity increases noted downstream of Hound Creek (Plate I) are due to channel erosion, which probably has been accelerated by extensive agricultural activity. The Smith River between Hound Creek and the Missouri River is a meandering stream; many old meanders and oxbows are evident.

TABLE 22. TEMPERATURE DATA FOR THE SMITH RIVER NEAR EDEN, MT

SMITH RIVER BASIN

80. Smith River near Eden, Mont. (6-0775)

Location.--At gaging station, lat 47°12', long 111°23', in SW¼SW¼ sec.29, T.17 N., R.3 E., on left bank a quarter of a mile upstream from Mullens Creek, 2 miles upstream from Hound Creek, and 7 miles southwest of Eden. Altitude of gage is 3,500 ft (by barometer).

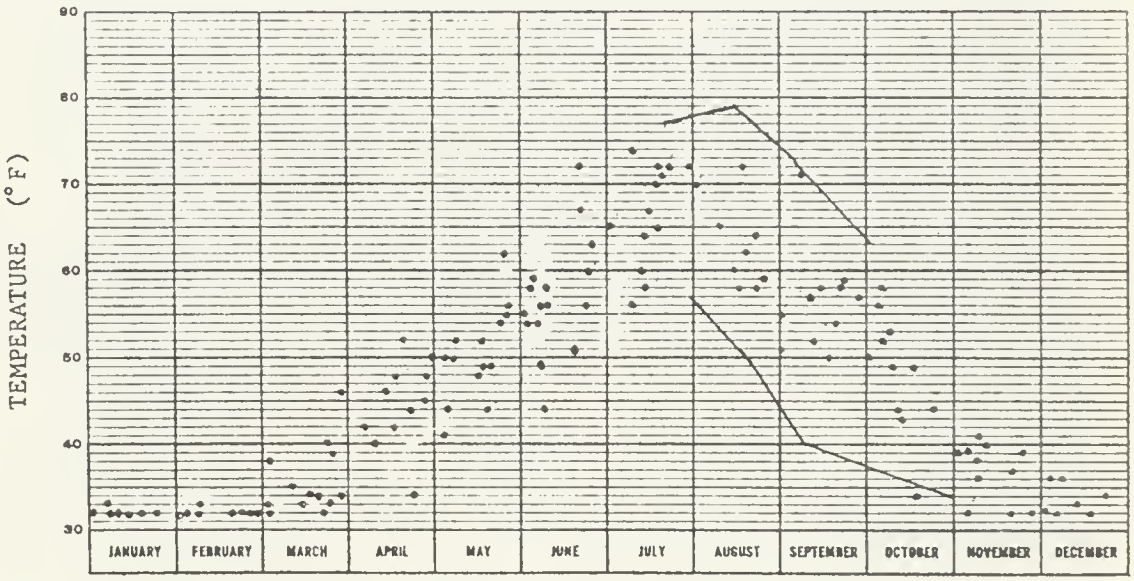
Drainage area.--1,594 sq mi.

Water temperature records available.--136 spot observations made at time of discharge measurements during period May 1951 to December 1965. Thermograph record on a seasonal basis (July to October) during period July 1962 to September 1964 published in this report.

Extremes.--Discharge 1951-65: Maximum, 12,300 cfs June 4, 1953; minimum observed, 3.1 cfs Sept. 1, 1961.

Water temperatures 1951-65: Maximum, 79°F Aug. 13, 14, 1963; minimum, freezing point on many days during winter months.

Cooperation.--Thermograph record furnished by Montana Fish and Game Department.



Spot observations of water temperatures, 1951-65.
The lines delineate the range between the highest and lowest temperature from seasonal thermograph record, 1962-64.

Summary of thermograph record

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1962	Max	--	--	--	--	--	--	--	73	64	57	--	--
	Min	--	--	--	--	--	--	57	50	40	42	--	--
1963	Max	--	--	--	--	--	--	77	79	73	63	--	--
	Min	--	--	--	--	--	--	58	58	53	34	--	--
1964	Max	--	--	--	--	--	--	77	73	60	--	--	--
	Min	--	--	--	--	--	--	61	49	42	--	--	--

Extremes for years 1962-64

	Max	--	--	--	--	--	--	77	79	73	63	--	--
	Min	--	--	--	--	--	--	57	49	40	34	--	--

BELT CREEK

Headwaters of Belt Creek are in the Little Belt Mountains southeast of Great Falls, Montana. Portions of the Little Belts drained by Belt Creek are highly mineralized and have been sites of mining activity since the 1800's. Flowing south to its junction with the Missouri River, Belt Creek is paralleled by U. S. Highway 89 for about half its length. Summer home and camp development along the stream has been popular with Great Falls residents for many years. Belt Creek leaves the Little Belts and enters a narrow foothills valley at Riceville, Montana. The valley widens at Belt, Montana, but the general land relief remains moderate. Extensive coal deposits exist adjacent to Belt. They have been worked sporadically since 1876.

Belt Creek near Neihart has moderately hard, calcium bicarbonate water with low sulfate, chloride, magnesium and sodium concentrations and low turbidity. Metal concentrations at the near Neihart station (Table 19) generally were low, except during spring runoff. Because mining activity has been very slight in this segment of the Belt Creek drainage and no acid mine seeps are known, metal concentrations are attributed to mineralization of the area. Metal concentrations near Monarch (above the Dry Fork) were significantly higher than near Neihart. Carpenter Creek, site of the Montana Mining District, drains into this reach of Belt Creek and is the probable metals source. The Dry Fork of Belt Creek, which joins Belt Creek at Monarch (Plate I), has been degraded severely by acid mine drainage from the Hughesville-Barker area (Section VI). Belt Creek below Riceville loses much of its flow to channel seepage and often is dry just above its confluence with Otter Creek (near Belt, Montana). Seeps from inactive coal mines near Belt (Plate I) contribute additional acid mine drainage to Belt Creek (Section VI). Specific conductance and pH of a seep, known as Belt's Orange Creek, were 2,217 micromhos per centimeter at 25° C and 2.9, respectively.

MISSOURI RIVER - TRIDENT TO FORT BENTON

The Missouri River is formed by the confluence of the Madison, Jefferson and Gallatin Rivers near Trident, Montana. Water quality in the river is a composite of these tributaries. From Trident to Fort Benton, the Missouri undergoes several water quality changes. Contributing to this transition are three major impoundments stretching almost headwater to tailrace for 70 miles between Townsend and Wolf Creek, numerous discharges of municipal and industrial

wastes, agricultural activities, a geological transition as the river leaves the mountains and enters the Northern Great Plains, plus inflow of three large tributaries. As a result of these factors, there is a water quality transition, and the river changes from a salmonid fishery above Great Falls to a warm-water fishery at Fort Benton.

The river is a hard, calcium bicarbonate water with lesser concentrations of magnesium, sodium, sulfate and chloride (Table 20). Canyon Ferry Reservoir is serving as a sink for iron (Table 23), indicating a general lack of anaerobic conditions at the water-bottom sediment interface. A net reduction of phosphorous should also occur, but sampling was insufficient to verify this. Iron and zinc concentrations were significantly higher below Morony Dam than below Holter Dam. Increased iron concentrations are caused by high iron concentrations entering from the Sun River. Increased zinc concentrations probably are due to industrial discharges from the Anaconda Company, Great Falls (Section VI). Turbidity measurements from Canyon Ferry to Holter Dams ranged between 0.7 JTU and 3 JTU. Turbidity increases noted below Morony are due to high sediment loads carried by the Sun River. Turbidities below Morony Dam ranged from 3 JTU to 11 JTU. Discharge of poorly chlorinated primary effluent from the Great Falls municipal sewage treatment plant is the probable cause of high coliform densities noted at Fort Benton. Four-hundred sixty total coliform organisms per 100 ml and 680 total coliform organisms per 100 ml were present in samples collected on July 11 and October 18, 1973, respectively. High fecal coliform levels at Fort Benton have been determined by USGS sampling. For monthly samples between October, 1970 and September, 1971, densities ranged from 3 organisms per 100 ml to 700 organisms per 100 ml (1970 USGS Water Resources Data, Part 2, Water Quality Records, 1972). Moderate fluoride levels in the river are derived from Yellowstone Park thermal springs. Typical fluoride concentrations entering Canyon Ferry Reservoir are 1.2 mg/l and vary from 0.95 mg/l to 1.4 mg/l. Fluoride levels at the Morony Dam station vary from 0.17 mg/l to 1.0 mg/l.

TABLE 23. TOTAL RECOVERABLE IRON CONCENTRATIONS IN THE MISSOURI RIVER ABOVE AND BELOW CANYON FERRY RESERVOIR

USGS STATION AT TOSTON		WQB STATION AT TOWNSEND		USGS STATION BELOW CANYON FERRY	
Date	Concentration(1)	Date	Concentration(1)	Date	Concentration(1)
6/7/73	0.52	8/24/72	0.25	6/21/73	0.06
10/4/73	0.21	9/20/72	0.22	8/1/73	0.07
		1/18/73	0.20	10/11/73	0.06
		3/1/73	0.27		
		4/6/73	1.0		
		5/10/73	1.27		

(1) milligrams per liter

IX. WASTE DISCHARGE PERMITS

The Montana state program of issuing waste discharge permits is operated under authority of the Montana water pollution control law. Statutory authority to apply and enforce state compliance schedules in state permits are Sections 69-4806(3), 4808.2(1)(f)(1) and (2), 69-4820, 69-4820.1, and 69-4823, Revised Codes of Montana, 1947. The applicable rule is existing MAC 16-2.14(10)-S14460, Montana Pollutant Discharge Elimination System (MPDES), Section (2)(b)(ii), effective March 8, 1974. Fourteen municipal, 12 industrial and three agricultural waste discharge permits have been issued (July 30, 1974) by the state in the Missouri-Sun-Smith basin.

The U. S. Environmental Protection Agency (EPA) also is issuing waste discharge permits in Montana. As of July 30, 1974, 40 NPDES permits (Table 24) have been or will be issued for discharges or potential discharges in the Missouri-Sun-Smith basin. Dischargers not assigned a permit number had not made application as of July 30, 1974. Approximately 12 additional permits for agricultural discharges are anticipated. All municipalities on compliance schedules are expected to meet secondary treatment requirements by July 1, 1977. Facility descriptions and effluent characteristics are discussed in Section VI.

TABLE 24. NPDES PERMITS IN THE MISSOURI-SUN-SMITH BASIN
(Current as of July 30, 1974)

Facility	NPDES Permit No.	Date Issued	Expiration Date	Compliance Schedule
Great Falls, MT Sewage Treatment Plant	MT 0021920	2/26/74	12/31/76	(2) 6/1/77
Great Falls, MT Water Treatment Plant	MT 0000442	11/30/73	7/1/76	(1) 7/1/77
Helena, MT Sewage Treatment Plant	MT 0022641	3/19/74	1/31/76	(2) 3/31/75
Helena, MT Water Treatment Plant	MT 0000949	11/30/73	7/1/76	None required
Malmstrom Air Force Base Sewage Treatment Plant	MT 0020443	7/12/74	3/31/77	Eliminate illicit storm sewer connection by 9/1/75. Meet interim limitations by 4/1/75 and secondary by 7/1/77.
Augusta, MT lagoon	MT 0021971	11/27/73	7/1/76	None required
Cascade, MT lagoon	MT 0021954	11/26/73	7/1/76	(2) 7/1/77
East Helena, MT lagoon	MT 0022560	6/14/74	12/1/76	Date unspecified
Fort Benton, MT lagoon	MT 0021601	6/14/74	12/1/76	Date unspecified

(1) Best practicable treatment by date specified.

(2) Discharge must meet secondary effluent requirements by date specified.

Facility	NPDES Permit No.	Date Issued	Expiration Date	Compliance Schedule
Fort Benton, MT Water Treatment Plant	MT 0000915	11/30/73	7/1/76	(1) 7/1/77
Montana Power Co. Sewage Treatment Plants				
Hauser (001)	MT 0020648	3/22/74	7/1/77	None required
(002)	MT 0020648			
(003)	MT 0020648			
Holter Dam	Pending	To public notice; permit will be issued by 9/1/74.		
Rainbow Dam (001) (002)	Pending	To public notice; permit will be issued by 9/1/74.		
Black Eagle Dam	Pending	To public notice; permit will be issued by 9/1/74.		
Ryan Dam	Pending	To public notice; permit will be issued by 9/1/74.		
Mountain View School for Girls, Helena, MT	MT 0021946	11/19/73	7/1/77	None required
Belt, MT Lagoon	MT 0021571	7/30/74	12/31/76	Date unspecified
Highwood, MT Lagoon	MT 0022080	Pending; permit will be required when facility completed (Section VI)		
Townsend, MT Lagoon	MT 0020508	11/21/73	7/1/76	(2) 7/1/77
White Sulphur Springs, MT Laggon	MT 0020699	11/21/73	7/1/76	(2) 7/1/77
Fairfield, MT Lagoon	MT 0020290	Pending; to public notice; permit will be issued by 9/1/74		
Vaughn, MT sewage treatment plant and lagoon.	MT 0021440	7/30/74	6/30/79	(2) 1/1/75
Power, MT water treatment plant	MT 0001066	1/11/74	12/31/76	(1) 1/1/76
Alhambra Manor	Pending; application not received.			

(1) Best practicable treatment by date specified.

(2) Discharge must meet secondary effluent requirements by date specified.

Facility	NPDES Permit No.	Date Issued	Expiration Date	Compliance Schedule
Ideal Cement Co., Trident, MT				
Industrial	MT 0000485	9/21/73	7/1/78	None required
Sewage Treatment Plant				
Kaiser Cement Co., Montana City, MT				
Industrial (001)	MT 0000451	9/21/73	7/1/78	None required
Industrial (002)				
National Clyinder Gas Co., East Helena, MT				
Industrial	MT 0000426	7/3/74	12/31/78	None required
American Smelting and Refining Co., East Helena, MT				
Industrial	MT 0000345	6/14/74	12/31/78	None required
Ayrshire Dairy, Great Falls, MT				
Industrial	MT 0001074	11/2/73	1/1/76	(1) 7/1/74
Burlington Northern, Great Falls, MT				
Industrial	MT 0000361	1/11/74	12/31/75	(1) 7/1/75
Bureau of Reclamation, Canyon Ferry, MT				
Trickling Filter	MT 0020605	Pending		None required
Extended Aeration	MT 0020061	Pending		None required
Phillips Petroleum, Great Falls, MT				
Industrial	MT 0000434	7/31/73	7/1/76	None required
Anaconda Co., Great Falls, MT				
Industrial (001)	MT 0000493	5/31/74	7/1/76	None required
(002)				(1) 1/1/75
(003)				(1) 1/1/75
(004)				(1) 1/1/74 or eliminate discharge
(005)				(1) 1/1/75

(1) Best practicable treatment by date specified.

(2) Discharge must meet secondary effluent requirements by date specified.

Facility	NPDES Permit No.	Date Issued	Expiration Date	Compliance Schedule
Giant Springs Fish Hatchery, Great Falls, MT	MT 0000990	11/29/73	6/30/77	(1) 7/1/77
Great Falls Meat Co., Great Falls, MT Industrial	Pending; application not received			
McLeod Farm, Helena, MT Feedlot	MT 0022497	Pending		
Spencer Feedlot, Great Falls, MT	MT 0022446	Pending		
McIver Ranch Co., Great Falls, MT Feedlot	MT 0022284	6/19/74	3/31/77	None required
Blake M. Tippetts, Ft. Shaw, MT Feedlot	MT 0022217	Pending		
Eidel Ranch Co., Great Falls, MT Feedlot	MT 0022781	Pending		
K. C. Gourley, Augusta, MT Feedlot	MT 0022209	Pending		
Sun River Cattle Co., Vaughn, MT Feedlot	MT 0022527	6/14/74	3/31/77	None required
HDS Inc. Feeders, Vaughn, MT Feedlot	MT 0022179	6/14/74	3/31/77	None required
Helena Valley Irrigation District	MT 0023434	Pending		
Greenfields Irrigation District	MT 0023124	Pending		

(1) Best practicable treatment by date specified.

(2) Discharge must meet secondary effluent requirements by date specified.

Federal permits are issued pursuant to the National Pollutant Discharge Elimination System (NPDES) created by the Federal Water Pollution Control Act Amendments of 1972 (FWPCAA of 1972). To eliminate the duplication of effort which formerly existed, Montana was given the authority to administer the NPDES program in Montana on June 10, 1974. Section 402 of the FWPCAA of 1972 provides that states with adequate water pollution control program elements may apply for and receive authority from the EPA to issue permits under the NPDES in their own states. Montana made the necessary revisions to the state water pollution control laws during the 1973 legislative session to provide the statutory authority for administration of the aforementioned NPDES program in Montana. In addition, the Board of Health and Environmental Sciences adopted a rule entitled the Montana Pollutant Discharge Elimination System (MPDES). The MPDES rule provides the additional program elements needed by the state to comply with rules and regulations promulgated by the administrator of EPA pursuant to Section 304(h) of the FWPCAA of 1972. Section 304(h) relates to the state program elements necessary to administer the NPDES program.

X. WASTE LOAD ALLOCATIONS

Muddy Creek and the Sun River from Muddy Creek to the Missouri River are water quality limited segments because of high sediment loads due principally to poor irrigation practices in the Muddy Creek drainage. Effluent from the Imhoff tank at Vaughn is the only discharge in these segments (Section VI). Effluent from this facility has no measurable effect on sediment load to Muddy Creek. So, no waste load allocation has been made.

The Missouri River from the Sun River to the Marias River is a water quality limited segment because of high sediment load originating in the Muddy Creek drainage and high coliforms from the present Great Falls municipal treatment plant discharge. The application of secondary treatment will be adequate to meet fecal coliform limits imposed by state water quality standards. The city of Great Falls is on a compliance schedule to provide secondary treatment (BPT) by June 1, 1977 (Section VI and Table 24).

The Missouri River from Canyon Ferry Reservoir to Holter Dam has been classified as water quality limited because of nuisance algal blooms. Nutrient inputs to the Missouri upstream of Holter Dam have not been investigated adequately; however, preliminary investigations have indicated large inputs from irrigation in the Crow Creek drainage (Sections III and VIII). Helena is the only major domestic wastewater discharger between the three forks of the Missouri and Holter Dam, but Helena's effects on nuisance algal populations are not known at this time. Minor domestic wastewater discharges at Trident, Townsend, Canyon Ferry Dam, East Helena and Hauser Dam (Section VIII) are believed to make no measurable contribution to the algal problems. Additional study is needed before waste load allocations can be made for the Missouri River from Canyon Ferry Reservoir and Holter Dam. Therefore, a study entitled, NUTRIENT LOADS IN THE UPPER MISSOURI DRAINAGE, MONTANA, has been initiated (Section III) by the Water Quality Bureau through a grant from the EPA.

Sand Coulee Creek and Belt Creek below, but including the Dry Fork of Belt Creek, have been classified as water quality limited because of acidity and metals problems due to past mining activities. Effluent from the Belt

lagoon (Section VI) is the only discharge to Belt Creek. Effluent from the lagoon does not increase the metals levels in Belt Creek; so, no waste load allocation has been made. There are no MPDES discharges to Sand Coulee Creek.

There are no other designated water quality limited segments in the Missouri-Sun-Smith basin.

XI. MANAGEMENT AND STRATEGY PLAN

A water quality management strategy should be designed to maintain and enhance water quality in the basin. The strategy also must consider requirements of all federal and state laws and regulations. The Federal Water Pollution Control Act Amendments of 1972 provide that for all discharges other than publicly owned treatment works, not later than July 1, 1977, effluent limitations are to be achieved which represent application of best practicable control technology currently available. All publicly owned treatment works must achieve secondary treatment by July 1, 1977.

The Missouri-Sun-Smith basin contains 20 percent of Montana's population or about 121,000 persons. Eleven municipalities and 15 industries discharge wastes to streams within the basin. So, this basin is more complex than most others in Montana. However, only Helena, Great Falls, American Smelting and Refining Company and Anaconda Company are considered major dischargers.

From a basin strategy, management programs or plans can be developed and implemented. After plan development and implementation, water and wastes in the basin must be checked to determine the actual influence of the plan on basin waters. Water quality management is an iterative process; that is, a plan must be followed, the results checked and the program modified, and the results checked again. In the Missouri-Sun-Smith basin, the basic strategy will consist of:

1. Permits will be used to regulate pollutant discharges.

2. Waste discharges will be monitored to ensure compliance with NPDES and MPDES permit conditions. Suspended residue, BOD5, fecal coliforms and flow will be monitored in all municipal discharges; residual chlorine will be measured where chlorination is provided. Municipal water treatment plant discharges will be monitored for aluminum, suspended residue, turbidity, flow, pH, and residual chlorine. Temperature and flow will be monitored in cooling water discharges plus zinc and lead in the cooling water discharges of American Smelting and Refining Company, East Helena. Selected metal concentrations specified

in NPDES Permit No. MT 0000434 will be monitored in metal processing wastewater discharges of the Anaconda Company, Great Falls. NPDES discharge permits are pending for several feedlot operations in the Missouri-Sun-Smith basin, but wastewater discharge limitations have not been developed.

3. The Water Quality Bureau will participate with other regulatory agencies in controlling land use activities to abate potential pollution problems.

4. Followup in-depth studies will be conducted on known or suspected pollution problems.

5. Selected water quality monitoring stations will be continued.

Authority to apply and enforce state compliance schedules in state permits is discussed under Section IX. Authority to enforce stream water quality standards is discussed in Appendix B.

XII. SURVEILLANCE PLAN

A surveillance plan is useful for monitoring existing discharges for compliance with permit conditions, checking in-stream water quality against Montana's water quality standards and detecting long-term water quality changes in the basin. Therefore, upon completion of the Missouri-Sun-Smith Water Quality Inventory and Management Plan, a long-range water quality surveillance network will be maintained (Table 25). This will be in addition to studies of identified problem areas (Sections VI and VIII).

Municipal, industrial and agricultural discharges will be monitored for compliance with state and federal permits. Municipalities, industries and agricultural dischargers will be required to monitor their discharges. Frequency and parameters will be in accordance with the MPDES, and results will be submitted to the Water Quality Bureau and EPA. The Water Quality Bureau will also collect and analyze samples from these discharges. Major industrial and municipal discharges will be sampled yearly. Approximately 50 percent of the minor municipal discharges will be sampled yearly with the balance sampled in alternate years.

TABLE 25. MISSOURI-SUN-SMITH WATER QUALITY SURVEILLANCE STATIONS

STATION NAME	AGENCY AND NO.	LOCATION[1]	SAMPLING INTERVAL	WATER QUALITY PARAMETERS
Missouri River at Toston, MT	USGS 06054500	5N2E36BD	Monthly	Dissolved: Ca, Mg, Na, SO_4, Cl, F, Solids, NO_2 + NO_3, NH_3, Ortho Phosphorous, Phosphorous, Total P, Total N, Total Kjeldahl N, BOD, Specific conductance, Temperature, D.O., pH, Alkalinity, Flow
Missouri River below Canyon Ferry Dam	USGS 06058502	10N1W4DDB	Daily Composite	Dissolved: SiO_2, Fe, Ca, Mg, Na, K, SO_4, Cl, F, NO_2 + NO_3, Ortho Phosphorous, Solids, Phosphorous, B, Mn. HCO_3, CO_3, Specific conductance, pH, Temperature, Flow
Sun River below Diversion Dam near Augusta, MT	USGS 06080900	22N9W36	Daily Composite	Dissolved: SiO_2, Fe, Ca, Mg, Na, K, SO_4, Cl, F, NO_2 + NO_3, Ortho Phosphorous, Solids. HCO_3, CO_3, Specific conductance, pH, Flow, Temperature
Muddy Creek near Vaughn, MT	USGS 06088300	22N1E32AB	Daily Composite	Dissolved: SiO_2, Fe, Ca, Mg, Na, K, SO_4, Cl, F, NO_2 + NO_3, Ortho Phosphorous, Solids. HCO_3, CO_3, Specific conductance, pH, Flow, Temperature, Suspended Sediment
Muddy Creek at Vaughn, MT	USGS 06088500	21N1E24A	Daily Composite	Dissolved: SiO_2, Fe, Ca, Mg, Na, K, SO_4, Cl, Fe, NO_2 + NO_3, Ortho Phosphorous, Solids. HCO_3, CO_3, Specific Conductance, pH, Flow, Temperature, Suspended Sediment
Sun River near Vaughn, MT	USGS 06089000	21N2E33CDB	Daily Composite	Dissolved: SiO_2, Fe, Ca, Mg, Na, K, SO_4, Cl, F, NO_2 + NO_3, Ortho Phosphorous, Phosphorous, B, Mn. HCO_3, CO_3, Specific conductance, pH, Flow Temperature
Missouri River at Ft. Benton, MT	USGS 06090800	24N8E23DD	Monthly	Dissolved: Ca, Mg, Na, SO_4, Cl, F, Solids, NO_2 + NO_3, NH_3, Ortho Phosphorous, Phosphorous, O_2. Total Kjeldahl N, Total N, Total P, BOD, Alkalinity, Specific conductance, Temperature, Flow, Total and Fecal Coliforms.

(1) See Appendix C.

STATION NAME	AGENCY AND NO.	LOCATION (1)	SAMPLING INTERVALS	WATER QUALITY PARAMETERS
Smith River near White Sulphur Springs, MT	WQB	10N5E25CCC	Quarterly	Ca, Mg, Na, SO_4, Cl, HCO_3, CO_3, NO_3, PO_4, F, Specific conductance, pH, Turbidity, Suspended Solids, Temperature, Flow
Belt Creek near Mouth	WQB	21N5E12DDB	Quarterly	Ca, Mg, Na, SO_4, Cl, HCO_3, CO_3, NO_3, PO_4, F, Specific conductance, pH, Turbidity, Suspended Solids, Temperature, Flow, Fecal Coliforms, BOD5. Total recoverable As, Fe, Zn, Cu, Cd, Pb, Mn
Prickly Pear Creek at East Helena, MT	WQB	10N3W25D	Quarterly	Ca, Mg, Na, SO_4, Cl, HCO_3, CO_3, Kjeldahl-N, NH_3, Total P, PO_4, F, Specific conductance, pH, Turbidity, Suspended Solids, Temperature, Flow, Fecal Coliforms. Total recoverable As, Fe, Zn, Mn, Cu, Cd, Pb
Lake Helena	WQB	11N2W19A	Quarterly	Ca, Mg, Na, SO_4, Cl, HCO_3, CO_3, NO_3, Kjeldah-N, NH_3, Total P, PO_4, F, Specific conductance, pH, Turbidity, Suspended Solids, Temperature, Flow, Fecal Coliforms. Total recoverable As, Fe, Zn, Mn, Cu, Cd, Pb

(1) See Appendix C.

XIII. MUNICIPAL FACILITIES INVESTMENTS

State water quality standards in the Missouri-Sun-Smith basin will not be violated by any municipal discharges after the application of secondary treatment. Several facilities are in need of upgrading to meet secondary effluent standards. Needs, projected costs and scheduling are summarized in Table 26. Dated to evaluate cost effectiveness of treatment needs were not available.

TABLE 26. MUNICIPAL SEWAGE TREATMENT NEEDS IN THE MISSOURI-SUN-SMITH BASIN

Community	Needs Description	1990 Design Population	Cost Estimate	Status
Great Falls	Provide secondary treatment; increase capacity present primary plant; storm and sanitary sewer separation.	93,000	Secondary Treatment $12,050,000 Sewers 13,160,000 $25,210,000	Contracts 1, 2 and 3 of four-phase project to upgrade sewage treatment facility awarded.
Helena	Provide secondary treatment; sewer needs.	35,000	Secondary Treatment $1,800,000 Sewers $1,594,000 3,394,000	Secondary treatment facilities 75 percent completed. Sewer needs low on priority list.
Vaughn	Provide secondary treatment.	525	$147,900	Construction should be underway.
Townsend	Infiltration problem; provide secondary treatment	1,775	$613,000	Expect to be funded and begin work in FY 1975.
Fairfield	Infiltration problem; upgrade lagoon to provide secondary treatment.	650	Sewers $70,000 Lagoon $60,000 $130,000	No plans for improvement at this time. Low on priority list.
Fort Benton	Inadequate sewer; storm and sanitary sewer separation	2,000	Sewers $315,000 Lagoon $ 25,000 $340,000	Low on priority list; no funding likely for three or more years.

Community	Needs Description	1990 Design Population	Cost Estimate	Status
Belt	Provide secondary treatment.	600	$51,000	Not on priority list.
Cascade	Provide secondary treatment; infiltration problem.	750	Sewers $1,000 Lagoon $60,000 $61,000	Low on priority list.
East Helena	Infiltration problem; upgrade lagoon to provide secondary treatment.	2,500	$140,000	Should be funded in FY 1976.
Augusta	Upgrade lagoon to provide secondary treatment.	275	$20,000	Not yet on priority list.
White Sulphur Springs	Infiltration problem; needs not established.	950	$100,000	Not yet on priority list.
Stockett	Collection system; treatment facility.	750	$426,000	Low on priority list.
Ulm	Collection system; treatment facility.	600	$456,000	Low on priority list.
Simms	Collection system; treatment facility.	380	$471,000	Low on priority list.

APPENDIX

APPENDIX A

GLOSSARY

Symbol	Definition
NOAA	National Oceanographic and Atmospheric Administration
SCS	U. S. Department of Agriculture, Soil Conservation Service
BR	U. S. Department of the Interior, Bureau of Reclamation
NPDES	National Pollutant Discharge Elimination System
WQB	Montana Department of Health and Environmental Sciences, Environmental Sciences Division, Water Quality Bureau
mgd	million gallons per day
BOD5	five-day biochemical oxygen demand
gpd	gallons per day
tpd	tons per day
gpm	gallons per minute
mg/l	milligrams per liter
USGS	U. S. Geological Survey
cfs	cubic feet per second
JTU	Jackson Turbidity Units
$\mu\mho$	Micromhos per centimeter

Symbol	Definition
TR	Total recoverable
EPA	U. S. Environmental Protection Agency
$<$	less than
$\sim$	approximately
$\leq$	less than or equal to
F & G	Montana Department of Fish and Game
ml	milliliter
MPDES	Montana Pollutant Discharge Elimination System
BPT	Best Practicable Treatment

MONTANA STATE DEPARTMENT OF HEALTH
AND
ENVIRONMENTAL SCIENCES

MAC 16-2.14(10)-S14480 WATER QUALITY STANDARDS

(1) Policy statement. The following standards are adopted to establish maximum allowable changes in water quality and establish limits for pollutants which affect prescribed beneficial uses of state waters. The department adopts as a rule the policy that best practicable treatment and control of waste, activity and flow is to be provided to maintain dissolved oxygen and overall water quality at the highest possible levels, and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor and other deleterious substances at the lowest possible levels.

(2) Application of standards. The water quality standards are composed of water-use classifications [section (4)], water-use descriptions and specific water quality criteria [section (5)], and general water quality criteria [section (6)].

(a) General water quality criteria apply to all state waters except where in this rule specific water quality criteria are more applicable to a specific water-use classification.

(b) In order to carry out the objective of the rule, existing discharges to state waters shall be brought into compliance with the standards as soon as practicable, and in no case later than three years from the effective date of the rule.

(3) Definitions. Unless statutory definition or the context otherwise requires in this rule:

"Conduit" means any artificial or natural duct, either open or closed, for conveying liquids or other fluids.

"Dewatered stream" means a perennial or intermittent stream whose water has been removed for one or more beneficial uses.

"EPA" means the U. S. Environmental Protection Agency.

"Intermittent stream" means a stream or portion of a stream that flows only in direct response to precipitation; it receives little or no water from springs and no long-continued supply from melting snow or other sources.

"Naturally occurring" means conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil and water conservation practices have been applied. Conditions resulting from dams in existence as of July 1, 1971 are natural.

"Mixing zone" means that volume of state water wherein any pollutant may exceed allowable water quality standards.

"Pesticide" means insecticides, herbicides, rodenticides, fungicides or any substance or mixture of substances intended for preventing, destroying, controlling, repelling, altering life processes, or mitigating any insects, rodents, nematodes, fungi, weeds and other forms of plant or animal life.

"Residue" means oils, floating solids and sludge deposits.

"Sediment" means solid material settled from suspension in a liquid; mineral or organic solid material that is being transported or has been moved from its site of origin by air, water or ice and has come to rest on the earth's surface, either above or below sea level; or inorganic or organic particles originating from weathering, chemical precipitation or biological activity.

"Settleable solids" means inorganic or organic particles that are being transported or have been transported by water from the site or sites of origin and are settled or are capable of being settled from suspension.

"Sewer" means a pipe or conduit that carries wastewater or drainage water.

"State waters" means any body of water, irrigation system or drainage system, either surface or underground. This section shall not apply to irrigation waters where the waters are used up within the irrigation system and said waters are not returned to any other state waters. The term "state waters" as used in this rule does not include underground water.

"Storm sewer" or "storm drain" means a sewer that carries storm water and surface water, street wash and other wash waters, or drainage but excludes sewage and industrial wastes.

"True color" means the color of water from which the turbidity has been removed.

"Turbidity" means a condition in water or wastewater caused by the presence of suspended matter resulting in the scattering and absorption of light rays.

(4) Water-use classifications.

MISSOURI BASIN

Missouri River Drainage

Missouri River:

Missouri River drainage to the Sun River in Great Falls except tributaries listed below B-D1

Prickly Pear Creek drainage to the Montana Highway No. 433 crossing about one mile northwest of East Helena except the tributaries listed below . . . . . B-D_1

McClellan Creek drainage to the East Helena water supply intake . . . . . A-Open-D_1

Remainder of McClellan Creek drainage . . . . . B-D_1

Prickly Pear Creek (mainstem) from the Montana Highway No. 433 crossing about one mile northwest of East Helena to Lake Helena . . . . . E-F

Tributaries of Prickly Pear Creek from the Montana Highway No. 433 crossing to its mouth except those tributaries listed below . . . . . B-D_1

Ten Mile Creek drainage to the Helena water supply intake . A-Open-D_1

Remainder of Ten Mile Creek drainage . . . . . B-D_1

Willow Creek drainage (tributary of the Smith River, tributary to the Missouri River) to the White Sulphur Springs water supply intake . . . . . A-Closed

Remainder of the Willow Creek drainage . . . . . B-D_1

Missouri River (mainstem) from Sun River to Rainbow Dam . . . . B-D_2

Missouri River drainage from Rainbow Dam in Great Falls to the North Dakota state line except the portion of the mainstem and the tributaries listed below . . . . . B-D_3

Sun River drainage to but excluding Muddy Creek near Vaughn . . . . . B-D_1

Muddy Creek drainage . . . . . E-F

Sun River (mainstem) from Muddy Creek to the Missouri River . . . . . B-D_3

Tributaries (if any) to the Sun River from Muddy Creek to the Missouri River . . . . . B-D_1

Belt Creek drainage to and including Otter Creek except portion of O'Brien Creek listed below . . . . . B-D_1

O'Brien Creek drainage to the Neihart water supply intake . . . . . A-Open-D_1

Remainder of O'Brien Creek drainage . . . . . B-D_1

Belt Creek (mainstem) from Otter Creek to the Missouri River . . . . . B-D_2

Tributaries to Belt Creek from Otter Creek to the Missouri River . . . . . B-D_1

Highwood and Shonkin Creek drainages . . . . . B-D_1

(5) Water-use description and specific water quality criteria.

(a) General. Specific water quality criteria, along with criteria in section (6) protect the beneficial water uses set forth in the water-use descriptions for the following classifications of water. Criteria for organisms of the coliform group are based on a minimum of five samples obtained during separate 24-hour periods during any consecutive 30-day period analyzed by the most probable number or equivalent membrane filter methods. The metal limits on the Clark Fork River [section (6)] are to govern when this section (5) imposes a conflicting requirement with that criteria.

(b) A-Closed classification.

(i) Water-use description. Water supply for drinking, culinary and food processing purposes suitable for use after simple disinfection. Public access and activities such as livestock grazing and timber harvest are to be controlled by the utility owner under conditions prescribed and orders issued by the department. Only those waters on which access is presently controlled by the utility owner have been classified as A-Closed. If other uses are permitted, the waters are to be reclassified A-Open-D_1.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the coliform group is not to exceed 50 per 100 milliliters.

(ab) Dissolved oxygen criteria are not applicable for the classification.

(ac) No change from natural pH is allowed.

(ad) No increase above naturally occurring turbidity is allowed.

(ae) No increase above naturally occurring water temperature is allowed.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) No increases of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, above naturally occurring concentrations, are allowed.

(ah) No wastes are allowed which increase radioactivity above natural background levels.

(c) A-Open-D_1 classification.

(i) Water-use description. Water supply for drinking, culinary and food processing purposes suitable for use after simple disinfection and removal of naturally present impurities. Water quality is to be maintained suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. Where the waters are used for swimming or other water-contact sports, analyses are to be made by the utility owner and the department to determine if a higher degree of treatment is required for potable water use.

Waters, if shown to meet the A-Closed criteria, may be so classified by the department at the request of the utility owner. State waters within the boundaries of national parks and nationally designated wild, wilderness or primitive areas in the state are classified A-Open-D_1 except those adjacent to developed areas such as Snyder Creek through the community of Lake McDonald and Swiftcurrent Creek below the Many Glacier Chalet, both in Glacier National Park. Also, Georgetown, Flathead and Whitefish lakes and Lake Mary Ronan are classified A-Open-D_1 as are some streams presently used for domestic water supply.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the coliform group is not to exceed 50 per 100 milliliters where demonstrated to be the result of domestic sewage.

(ab) Dissolved oxygen concentration is not to be reduced below 7.0 milligrams per liter.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 is to be maintained above 7.0.

(ad) No increase above naturally occurring turbidity is allowed.

(ae) A 1° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 66° F; within the naturally occurring range of 66° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) Concentrations of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, after treatment for domestic use, are not to exceed the recommended limits established in the 1962 U. S. Public Health Service Drinking Water Standards or subsequent editions; an increase of more than 10 percent of the concentration present in the receiving water is not allowed; maximum allowable concentrations are to be less than acute or chronic problem levels as revealed by bioassay or other methods.

(ah) True color is not to be increased more than two units above naturally occurring color.

(d) B-D1 classification.

(i) Water-use description. The quality is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters, nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters, nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.

(ab) Dissolved oxygen concentration is not to be reduced below 7.0 milligrams per liter.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 is to be maintained above 7.0.

(ad) The maximum allowable increase above naturally occurring turbidity is 5 Jackson Candle Units except as is permitted in the general water quality criteria.

(ae) A 1° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 66° F; within the naturally occurring range of 66° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

This applies to all waters in the state classified B-D1 except for Prickly Pear Creek from McClellan Creek to the Montana Highway No. 433 crossing where a 2° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 65° F; within the naturally occurring range of 65° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) Concentrations of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, after treatment for domestic use, are not to exceed the recommended limits contained in the 1962 U. S. Public Health Service Drinking Water Standards or subsequent editions; no increase of more than 10 percent of the concentration present in the receiving water is permitted; maximum allowable concentrations are to be less than acute or chronic problem levels as revealed by bioassay or other methods.

(ah) True color is not to be increased more than five units above naturally occurring color.

(e) B-D_2 classification.

(i) Water-use description. The quality is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.

(ab) Dissolved oxygen concentration is not to be reduced below 7.0 milligrams per liter from October 1 through June 1 nor below 6.0 milligrams per liter from June 2 through September 30.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 9.0 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 is to be maintained above 7.0.

(ad) The maximum allowable increase above naturally occurring turbidity is 10 Jackson Candle Units, except as is permitted in the general water quality criteria.

(ae) A 1° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 66° F; within the naturally occurring range of 66° F to 66.5° F, no discharge is allowed which will cause the water temperature to exceed 67° F; and where the naturally occurring water temperature is 66.5° F or greater, the maximum allowable increase in water temperature is 0.5° F. A 2° F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55° F, and a 2° F maximum decrease below naturally occurring water temperature is allowed within the range of 55° F to 32° F.

(af) No increases above naturally occurring concentrations of sediment, settleable solids or residues, which adversely affect the use indicated, are allowed.

(ag) Concentrations of toxic or other deleterious substances, pesticides and organic and inorganic materials including heavy metals, after treatment for domestic use, are not to exceed the recommended limits contained in the 1962 U. S. Public Health Service Drinking Water Standards or subsequent editions, and no increase of more than 10 percent of the concentration present in the receiving water is permitted; maximum allowable concentrations are to be less than acute or chronic problem levels as revealed by bioassay or other methods.

(ah) True color is not to be increased more than five units above naturally occurring color.

(f) B-D3 classification.

(i) Water-use description. The quality is to be maintained suitable for drinking, culinary and food processing purposes after adequate treatment equal to coagulation, sedimentation, filtration, disinfection and any additional treatment necessary to remove naturally present impurities; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

(ii) Specific water quality criteria.

(aa) The average number of organisms in the fecal coliform group is not to exceed 200 per 100 milliliters nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliliters. The average number of organisms in the coliform group is not to exceed 1,000 per 100 milliliters nor are 20 percent of the samples to exceed 1,000 coliforms per 100 milliliters during any 30-day period.

(ab) Dissolved oxygen concentration is not to be reduced below 5.0 milligrams per liter.

(ac) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 9.0 is to be less than 0.5 pH unit. Natural pH outside this range is to be maintained without change. Natural pH above 7.0 shall be maintained above 7.0.

(ad) The maximum allowable increase above naturally occurring turbidity is 10 Jackson Candle Units, except as is permitted in the general water quality criteria.

(ae) A 3° F maximum increase above naturally occurring water temperature is allowed within the range of 32° F to 77° F; within the naturally occurring range of 77° F to 79.5° F, no thermal discharge is allowed which will cause the water

expected to occur on the average of once in ten years. When dilution flows are less than the above design flow at a point discharge, the discharge is to be governed by the permit conditions developed for the discharge through the waste discharge permit program.

(e) State surface waters are to be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will:

(i) Settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines.

(ii) Create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials.

(iii) Produce odors, colors or other conditions as to create a nuisance or render undesirable tastes to fish flesh or make fish inedible.

(iv) Create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life.

(v) Create conditions which produce undesirable aquatic life.

(f) No wastes are to be discharged and no activities conducted such that the wastes or activities, either alone or in combination with other wastes or activities, will violate, or can reasonably be expected to violate, any of the standards; (e.g., in a reach of stream classified B-D_1, the total allowable cumulative increase to naturally occurring turbidity conditions in the reach is 5 Jackson Candle Units).

(g) No wastes are to be discharged and no activities conducted which, either alone or in combination with other wastes or activities, will cause turbidities to exceed those allowed by specific water quality criteria; provided, short-term activities necessary to accommodate essential dredging, channel or bank alterations, stream diversions or other construction where turbidities in excess of the criteria are unavoidable, may be authorized by the department under conditions as it may prescribe.

(h) Methods of sample collection, preservation and analysis used to determine compliance with the standards are to be in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater published by the American Public Health Association or in accordance with tests or procedures that have been found to be equally or more applicable.

(i) For operations of existing water impoundments that cause conditions harmful to prescribed beneficial uses of state waters, it is to be

demonstrated to the satisfaction of the department that continued operations will be done in the best practicable manner to minimize harmful effects and will not violate state laws or department rules. New water impoundments shall be designed to provide temperature variations in discharging water that maintain or enhance the existing propagating fishery and associated aquatic life. As a guide, the following temperature variations are recommended: Continuously less than 40° F during the months of January and February, and continuously greater than 44° F during the months of June through September.

(j) Ponds for waste treatment purposes are not to be located in drainage ways where the volume of drainage water from a 10-year storm entering the ponds exceeds one-half the volume of the pond; provided that, subject to approval by the department as to design and maintenance, ponds located in drainage ways for the express purpose of containing emergency oil spills are permitted.

(k) Dumping of snow from municipal and/or parking lot snow removal activities into waters of the state is prohibited without a permit from the department.

(l) Existing discharges to state waters will be entitled a mixing zone as determined by the department.

(m) Until such time as minimum stream flows are established for dewatered streams, the minimum treatment requirements for discharges to dewatered receiving streams are to be no less than the minimum treatment requirements prescribed.

(n) Treatment requirements for discharges to intermittent streams are to be no less than the minimum treatment requirements prescribed.

(o) Pollution resulting from storm drainage, storm sewer discharges, and non-point sources, including irrigation practices, road building, construction, logging practices, overgrazing and other practices, are to be eliminated or minimized as ordered by the department.

(p) Application of pesticides in or adjacent to state waters is to be in compliance with the labeled direction, and in accordance with provisions of the Montana Pesticides Act (Title 27, Chapter 2, R.C.M. 1947) and the Federal Environmental Pesticides Control Act (Public Law 92-516). Excess pesticides and pesticide containers are not to be disposed of in a manner or in a location where they are likely to pollute state waters.

(q) The following radiological criteria shall apply to all waters except those classified as A-Closed:

(i) The average dissolved concentrations (including the naturally occurring or background contribution) of iodine 131, radium-226, strontium-89, strontium-90 and tritium are not to exceed the following concentration limits:

Iodine-131	5 pCi/L
Radium-226	1 pCi/L
Strontium-89	100 pCi/L
Strontium-90	10 pCi/L
Tritium	3,000 pCi/L

For all other radionuclides, the average dissolved concentration limits are to be 1/150 of the corresponding maximum permissible concentration in water for continuous occupational exposure as recommended by the National Committee on Radiation Protection (National Bureau of Standards Handbook 69 or subsequent revisions.)

(ii) For a mixture of radionuclides, the following relationship is to be satisfied:

$$\frac{C_1}{L_1} + \frac{C_2}{L_2} \cdots + \frac{C_n}{L_n} \leq 1.00$$

C denotes the average concentration of the respective radionuclide, and L denotes its concentration limit.

(iii) Where alpha emitters, strontium-90, radium-228, iodine-129, iodine-130 and lead-210 are known to be absent, routine analyses for dissolved gross beta radioactivity (excluding potassium-40 contribution) may be employed to monitor and show compliance with this criterion (except for tritium) as long as the gross concentration does not exceed 100 pCi/L. When these conditions are not met, routine quantitative analyses of individual radionuclides are to be performed to show compliance. Except in cases where tritium from other than natural sources is known to be absent, routine tritium analyses are to be performed to show compliance. (Note: "Absence" means a negligibly small fraction of the specific concentration limit, where the limit for unidentified alpha emitters is taken as the limit for radium-226.)

(iv) For radionuclides associated with suspended material in transport, the average concentration limits are to be 1/150 of the corresponding maximum permissible concentration in water (insoluble form) for continuous occupational exposure as recommended by the National Committee on Radiation Protection. In-stream sedimentation of these materials is not to produce solids beds that are not in compliance with subsections (q) (i) and (q) (ii) (because of leaching) and/or excessive accumulation in native flora and fauna.

(v) Average concentrations are to be computed from monitoring data acquired during the previous 12 months; maximum concentrations are not to exceed three times the average concentration limits specified.

(vi) Variances from concentration limits specified will be permitted only if the contributing source is non-controllable or a natural source. Best available treatment must be provided for man-made discharges, and the exposure received by affected population groups must be within established dose limits.

(r) No wastes are to be discharged and no activities conducted which, either alone or in combination with other wastes or activities, will result in the dissolved gas content relative to the water surface to exceed 110 percent of saturation.

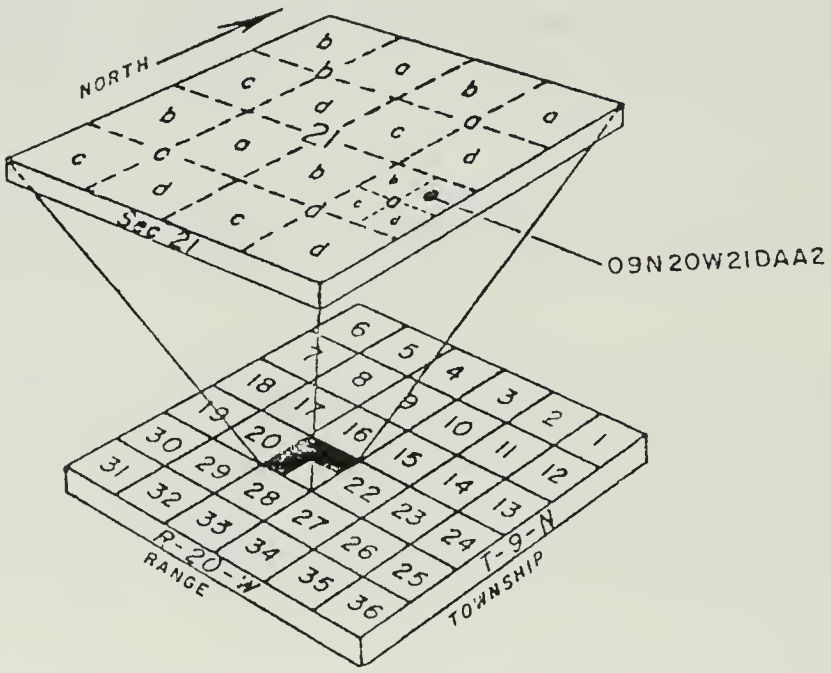
(s) Bioassay median tolerance concentrations are to be based on latest available research results for the materials, by bioassay tests procedures for simulating actual stream conditions as set forth in the latest edition of Standard Methods for the Examination of Water and Wastewater published by the American Public Health Association, or in accordance with tests or analytical procedures that have been found to be equal or more applicable by EPA. Bioassay studies are to be made using the most sensitive local species and life stages of economic or ecological importance; provided other species whose relative sensitivity is known may be used when there is difficulty in providing the most sensitive species in sufficient numbers.

When specific application factors are not available, the factor is to be determined by using methods listed in Water Quality Criteria published by the Federal Water Pollution Control Administration (1968), or by using other methods accepted as equal or applicable by EPA.

APPENDIX C

SYSTEM FOR GEOGRAPHIC LOCATION OF FEATURES

Wells, springs, water-sampling locations, and stream-gaging locations are assigned numbers based on the system of land subdivision used by the U. S. Bureau of Land Management. The number consists of twelve characters and describes the location by township, range, section, and position within the section. The figure below illustrates the numbering method. The first three characters of the number give the township, the next three characters the range. The next two numbers give the section number within the township, and the next three letters describe the location within the quarter section (160-acre tract) and the quarter-quarter section (40-acre tract), and the quarter-quarter-quarter section (10-acre tract). These subdivisions of the 640-acre section are designated a, b, c, and d in a counterclockwise direction, beginning in the northeast quadrant. If there is more than one feature in a 10-acre tract, consecutive digits beginning with 2 are added to the number. For example, if a water-quality sample was collected in sec.21,T.9N.,R20W, it would be numbered 09N20W21DAA2. The letters DAA indicate that the well is in the NE¼ of the NE¼ of the SE¼, and the number 2 following the letters DAA indicates there is more than one water-quality sampling location in this 10-acre tract.



REFERENCES

Missouri River Basin Inter-Agency Committee, 1969, Comprehensive Framework Study, Volumes 1 through 7.

National Oceanic and Atmospheric Administration. Climatological Data, Montana, Annual Summary, 1972 : 75 (13), March 14, 1973.

Keppner, Alfred. Montana Department of Health and Environmental Sciences Intraoffice Memorandum, January 24, 1974.

Steel, Ernest W. Water Supply and Sewerage. New York: McGraw-Hill, 1960.

Fair, Gordon M., John C. Geyer and Daniel A. Okun. Water and Wastewater Engineering : 2. John Wiley and Sons, New York, 1968.

Johnson, R. L., Regional Fisheries Manager, Great Falls, Montana. Montana Department of Fish and Game communication to Abraham Horpestad, 1974.

Brown, C. J. D., Fishes of Montana. Big Sky Books, Montana State University, Bozeman, Montana, 1971.

Konizeski, R. L., The Montanan's Fishing Guide: II, Mountain Press Publishing Company, Missoula, Montana, 1970.

Wipperman, A. H., Section I Fisheries Inventory and Plan in Smith River Drainage Inventory and Planning Investigation, Montana Fish and Game Department, Helena, MT, 1973.

Public Health Service Drinking Water Standards, 1962. U. S. Department of Health, Education and Welfare, Public Health Service Publication No. 956, Washington, D. C., August, 1962.

Montana Water Pollution Control Program Plan. Montana Department of Health and Environmental Sciences, Water Quality Bureau, June 27, 1973.

Basis of Design Memorandum, Project No. 5157, Great Falls, MT Wastewater Plant Improvements. Black and Veatch Consulting Engineers, Kansas City, Missouri, March 15, 1972.

Manual of Septic Tank Practice. U. S. Department of Health, Education and Welfare, Public Health Service Publication No. 526, Washington, D. C., 1967.

Design Report, Project No. 5157P, Great Falls, MT, Improvements to Wastewater Treatment Facilities. Black and Veatch Consulting Engineers, Kansas City, Missouri, 1970.

Helena City/County Sewer and Water Plan. Northwest Planners, Helena, MT, April, 1971.

Preliminary Engineering Concepts, Sewage Treatment Plant Improvements, Helena, MT. Morrison and Maierle, Inc., Helena, MT, February, 1972.

Wastewater Treatment Plant Improvements (for Helena, MT). Morrison and Maierle, Inc., Helena, MT, November, 1972.

Zollman, Donald M. Montana Department of Health and Environmental Sciences, Environmental Sciences Division, Water Quality Bureau communication, Dember 26, 1973.

Water Pollution Control in Cascade County. Montana Department of Health and Environmental Sciences, Environmental Sciences Division, Water Quality Bureau, December, 1972.

Missouri River Basin above Ervin Ridge Interim Water Quality Management Plan. Montana Department of Health and Environmental Sciences Division, Water Quality Bureau, January 25, 1972.

Comprehensive Area-Wide Water and Sewer Plan : 8, Lewis and Clark, Broadwater and Meagher Counties. Mueller, Jack F. and Theodore J. Wirth, December 12, 1970.

Comprehensive Area-Wide Water and Sewer Plan : 2, Glacier, Pondera and Teton Counties. Mueller, Jack F. and Theodore J. Wirth, December 12, 1970.

Comprehensive Area-Wide Water and Sewer Plan : 9, Chouteau, Judith Basin and Fergus Counties. Mueller, Jack F. and Theodore J. Wirth, December 12, 1970.

Alhambra Manor Wastewater Treatment Facilities, S & H Job No. 1613, Stahly and Harrington, Inc., Consulting Engineers, Helena, MT, December 8, 1971.

Public Notice No. MT-73-027. U. S. Environmental Protection Agency/State of Montana, November 21, 1973.

Phillips Petroleum Fact Sheet for NPDES Permit Application to Discharge Liquid Effluent, Application No. MT-2SB-OXT-2-000288. U. S. Environmental Protection Agency, June 20, 1973.

Ayrshire Dairy Fact Sheet for NPDES Permit Application to Discharge Liquid Effluent, Application No. MT-2SB-OXT-2-000900, U. S. Environmental Protection Agency, September 14, 1973.

Anaconda Company Fact Sheet for NPDES Permit Application to Discharge Liquid Effluent, Application No. MT 0000493, U. S. Environmental Protection Agency, July 22, 1971.

National Cylinder Gas Co. Fact Sheet for NPDES Permit Application to Discharge Liquid Effluent, Application No. MT 0000426, U. S. Environmental Protection Agency, July 26, 1971.

Montgomery, Richard T., Montana State Engineer for the U. S. Environmental Protection Agency, Helena, MT. Private communication to Robert D. Braico, December 27, 1973.

U. S. Army Corps of Engineers Permit Application No. MT-2SB-OXT-2-000153, American Smelting and Refining Company, October 18, 1972.

U. S. Army Corps of Engineers Permit Application No. MT-2SB-OXT-2-000324, Kaiser Cement, July 26, 1971.

Public Notice No. MT-73-018. U. S. Environmental Protection Agency/State of Montana, October 12, 1973.

Great Falls Water Treatment Plant Records for November, 1973. Great Falls, Montana.

Public Notice No. MT-73-015. U. S. Environmental Protection Agency/State of Montana, October 5, 1973.

Placer Gold Mining Company, Inc. Permit for Waste Discharge No. 10-W-3. Montana Board of Health and Environmental Sciences, Helena, MT, August 3, 1972.

Waste Treatment Lagoons for Great Falls Meat Company, Stage I, Job No. 11-63, Wenzel and Company, Great Falls, MT, March 29, 1963.

Traynor, James. The Effect of Acid Drainage Pollutant Upon Fish Habitat in Prickly Pear Drainage. Unpublished report, Montana Department of Fish and Game, Helena, MT, December, 1969.

Water Resources Survey, Cascade County. State Engineer's Office, Helena, MT, June, 1961.

Meeting between Helena National Forest and Montana Department of Health and Environmental Sciences representatives, May 5, 1973.

Water Resources Survey, Broadwater County, Montana. State Engineer's Office, Helena, MT, June, 1956.

Water Resources Survey, Jefferson County, Montana. State Engineer's Office, Helena, MT, June, 1956.

Chemical Analysis of Municipal Water Supplies. Montana State Department of Health and Environmental Sciences, Helena, MT, October 15, 1969.

Welch, Eugene B. Job Completion Report (specific title and number unknown), Montana Department of Fish and Game, Helena, MT, April 25, 1960.

Welch, Eugene B. "Belt Creek Fish Kill", letter to Nels Thoreson, Montana Department of Fish and Game, August 1, 1962.

"Report of Chemical Analysis of Water." Montana State Board of Health, Helena, MT, February 20, 1968.

"Report of Chemical Analysis of Water." Montana State Board of Health, June 2, 1967.

Boland, Ralph. Field Investigation, Montana Department of Health and Environmental Sciences, April 2, 1968.

Water Resources Survey, Lewis and Clark County, Montana. State Engineer's Office, Helena, MT, June, 1957.

Water Resources Survey, Meagher County, Montana. State Engineer's Office, Helena, MT, July, 1950.

Water Resources Survey, Teton County, Montana. State Engineer's Office, Helena, MT, July, 1962.

Water Resources Survey, Gallatin County, Montana. State Engineer's Office, Helena, MT, January, 1953.

Water Resources Survey, Park County, Montana. State Engineer's Office, Helena, MT, December, 1951.

Water Resources Survey, Chouteau County, Montana. State Engineer's Office, Helena, MT, June, 1964.

"Surface Water Stations in Operation as of October, 1972." U. S. Geological Survey, Helena, MT, October, 1972.

Water Resources Data for Montana, Part I. Surface Water Records, U. S. Geological Survey, Helena, MT, 1973.

Water Resources Data for Montana, Part I. Surface Water Records, U. S. Geological Survey, Helena, MT, 1969.

Compilation of Surface Water Records, Missouri River Basin Above Sioux City, Iowa, 1950-60. USGS Water Supply Paper 1729, United States Government Printing Office, Washington, D. C., 1964.

Compilation of Surface Water Records, Missouri River Above Sioux City, Iowa, Through 1950, USGS Water Supply Paper 1309, United States Government Printing Office, Washington, D. C., 1959.

Catalog of Information on Water Data, Index to Water Quality Section, U. S. Geological Survey, Washington, D. C., 1970.

Aagaard, Fern C. Temperature of Surface Waters in Montana, Montana Department of Fish and Game, Helena, MT, 1969.

McArthur, George M. Acid Mine Water Pollution Abatement, Sand Coulee Creek, Montana. Montana State University, Bozeman, MT, December, 1970.

Zollman, Donald M. Sun River Survey, Montana Department of Health, Division of Environmental Sanitation, Helena, MT, February 9, 1971.

Muddy Creek Study. Communication from Project Manager to Regional Director, Department of the Interior, Bureau of Reclamation, Upper Missouri Projects Office, Great Falls, MT, October 6, 1967.

Sun River Turbidity Studies. Communications from Project Manager to Regional Director, Department of the Interior, Bureau of Reclamation, Upper Missouri Projects Office, Great Falls, MT, December 17, 1971.

Waste Discharge Permit Application for Malmstrom AFB, U. S. Army Corps of Engineers No. MT-2SB-OXT-2-000714, January 27, 1972. NPDES Permit Application to Discharge Liquid Effluent, Application No. MT 0020443, Malmstrom AFB. U. S. Environmental Protection Agency, October 15, 1973.

Botz, M. K. Private communication to Robert D. Braico, January 24, 1974.

1970 Water Resources Data for Montana, Part 2, Water Quality Records. U. S. Geological Survey, Helena, MT, 1972.

"Sun River Sediment Problem," Unpublished Report, Bureau of Reclamation, Great Falls, MT, 1970.

1969 Water Resources Data for Montana, Part 2, Water Quality Records. U. S. Geological Survey, Helena, MT, 1971.

1968 Water Resources Data for Montana, Part 2, Water Quality Records. U. S. Geological Survey, Helena, MT, 1970.

Aycock, Gordon. Bureau of Reclamation, Great Falls, MT. Private communication to Robert D. Braico, January 29, 1974.

Garvin, W. H. Montana Department of Health and Environmental Sciences Field Investigation, Helena, MT., February 15, 1974.

Contract Documents for Construction of Sanitary Sewers and Waste Water Treatment Plant at Highwood, MT. Thomas, Dean and Hoskins, Consulting Engineers, Great Falls, Mt., July, 1973.

Boner, F. C. and G. W. Buswell. "A Proposed Streamflow-Data Program for Montana." U. S. Geological Survey, Helena, MT, 1970.

Black and Veatch Consulting Engineers. Communication to WQB, July 12, 1972.

Wetstein, Willis J., Morrison and Maierle, Consulting Engineers. Communication to WQB, May 3, 1972.

Turnbull and Plummer, Consulting Engineers, "Engineering Report on Sewage Treatment Facilities for Community of Vaughn, MT," September, 1968.

Offer and Acceptance of Federal Grant for Sewage Treatment Works, Vaughn Sewer District, February 4, 1973.

Smith, Thomas S. T. Montana Power Company communication to Robert D. Braico, WQB, January 21, 1974.

Eidel Ranch, Inc. NPDES Permit Application for Agricultural Discharge, No. MT 0022781, December 14, 1973.

Helena, Montana, City Engineer's Office. Communication to Robert D. Braico, December 17, 1974.

East Helena, Montana, City Engineer's Office. Communication to Robert D. Braico, June 28, 1974.

Great Falls, Montana, Water Supply Office. Communication to Robert D. Braico, July, 1974.

Aycock, Gordon, Bureau of Reclamation, Great Falls, MT. Private communication to Robert D. Braico, May 7, 1974.

Wright, John C. "The Limnology of Canyon Ferry Reservoir, I," Limnology and Oceanography : 3, 1958

Wright, John C. "The Limnology of Canyon Ferry Reservoir, II," Limnology and Oceanography : 4(3), July, 1959.

Wright, John C. "The Limnology of Canyon Ferry Reservoir, II," Limnology and Oceanography : 5(4), October, 1960.

Wright, John C. "The Limnology of Canyon Ferry Reservoir, II," Limnology and Oceanography : 6(3), July, 1961.

Wright, John C. "The Population Dynamics and Production of Daphnia in Canyon Ferry Reservoir, Montana." Limnology and Oceanography : 10(4), October, 1965.

Bahls, Loren L. "Eutrophication in Three Western Montana Lakes," in Environmental Quality Council First Annual Report, October, 1972.

Kaiser, Gerald Lynn. Population Dynamics of Rotifers and Some Factors Affecting Their Populations in Canyon Ferry Reservoir, Montana, MS Thesis in Botany, Montana State University, Bozeman, Montana, 1971.

The Missouri River Basin Comprehensive Study, 1 - 7. Missouri Inter-Agency Committee, December, 1971.

Bureau of Reclamation communication to Robert D. Braico, WQB. Great Falls, MT, May 23, 1974.

McKee, Jack Edward and Harold W. Wolf. Water Quality Criteria, second edition. California State Water Resources Control Board, Sacramento, California, 1963.

Sprague, J. B., P. F. Elson and R. L. Saunders. Sub-lethal Copper-Zinc Pollution in a Salmon River - A Field and Laboratory Study. Journal of the Fisheries Resource Board at Canada, 1965.

Regional Interim Project Water Quality Management Plan, Great Falls, Montana. Montana State Department of Health and Environmental Sciences, Helena, Montana, December 11, 1972.

Water Pollution Control in Cascade County. Montana State Department of Health and Environmental Sciences, Helena, Montana, December, 1972.

Interim Project Water Quality Management Plan, Highwood, Montana. Montana State Department of Health and Environmental Sciences, Helena, Montana.

RECEIVED
9/25/74

September 23, 1974

Our Bureau has just completed a water quality inventory and management plan for the Missouri River drainage from Trident, Montana to the mouth of the Marias River. Public hearing will be held on September 27, 1974 (Notice attached). Comments will be received at the hearing and by mail until October 28, 1974. We have also published notices concerning these hearings in local newspapers. Although the notices have been published, we are sending letters to persons and organizations that may have a particular interest in the area studied. Additional copies of the plan are available for $2.00 each to cover postage and handling costs. The report is large and reproduction takes considerable effort, so we hope those requesting copies would fully use and benefit from it.

Please contact our office if you desire a copy or if you would like to discuss any aspect of the plan.

Sincerely,

Robert D. Braico

Robert D. Braico
Water Quality Bureau
Environmental Sciences Division

RDB:vlf

Attachment

BEFORE THE DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES

NOTICE OF PUBLIC HEARING

for receiving comment on state water quality inventory and management plan as it concerns the Missouri River drainage between Trident, Montana and the mouth of the Marias River, Montana

1. On September 26, 1974, at 7:00 p.m., a public hearing will be held in the auditorium of the Montana Department of Highways Building, Sixth Avenue and Roberts Streets, Helena, Montana, to receive public comment on the state water quality management plan as it concerns the Missouri River drainage between Trident, Montana and the mouth of the Marias River, Montana basin. The water quality management plan is a part of the state water quality management plan which will become effective for the state of Montana under MAC 16-2.14(10)-S14480.

2. A summary of the water quality management plan follows. A complete copy of the proposed plan is available for inspection and copying at a reasonable fee at the Water Quality Bureau, Department of Health and Environmental Sciences, Cogswell Building, Helena, Montana 59601, or a copy may be inspected at bulletin boards located in the Gallatin, Park, Jefferson, Broadwater, Lewis and Clark, Meagher, Judith Basin, Cascade, Teton, and Chouteau County Courthouses at Bozeman, Livingston, Boulder, Townsend, Helena, White Sulphur Springs, Stanford, Great Falls, Choteau, and Fort Benton, Montana.

This water quality management plan presents information relative to water quality and water quality management in the Missouri River drainage between Trident, Montana and the mouth of the Marias River, Montana. The objectives of this effort are to provide the state with water quality data and related information to (1) determine the water characteristics of all natural and wastewaters, (2) determine what factors, both natural and manmade, affect the quality of the water, and (3) develop a management strategy for maintaining and enhancing the quality of waters in the basin. The scope of the plan will include (1) a description of the water and water-related resources of the basin, (2) a description and characterization of all point and non-point sources of pollution and the quality of natural waters in the basin, and (3) information needed to determine whether Montana's water quality standards are and will continue to be met.

3. Interested persons may present information, views, or arguments, whether orally or in writing, at the hearing. Important or detailed testimony should be offered for the record in writing.

4. Robert Braico, Helena, Montana, has been designated by the Director of the Department to preside over and conduct the hearing.

5. The authority of the Department to conduct said hearing is based on Section 69-4814, R.C.M. 1947.

JOHN S. ANDERSON, M.D., Director,
Department of Health and
Environmental Sciences

MISSOURI — SUN — SMITH

WATER QUALITY BUREAU
STATE DEPARTMENT OF HEALTH
AND ENVIRONMENTAL SCIENCES
AUGUST 1974

EXPLANATION

- COUNTY BOUNDARY
- PERENNIAL STREAM
- INTERMITTENT STREAM
- STREAM FLOW GUAGING STATION
- U.S.G.S. SAMPLING SITE
- NON DISCHARGING SEWAGE TREATMENT FACILITY
- SEWAGE TREATMENT FACILITY DISCHARGE
- WATER QUALITY SAMPLING SITE
- INDUSTRIAL DISCHARGE
- WATER TREATMENT PLANT DISCHARGE
- HYDROLOGICAL DRAINAGE BASIN BOUNDARY

SCALE

0 2 4 6 8 10

1/4" = 1 MILE

NOTE: THIS MAP WAS COMPILED FROM THE MONTANA STATE HIGHWAY DEPARTMENT COUNTY MAP SHEETS.